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# NOTES ON CALIFORNIAN MYXOSPORIDIA

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Although, as Kudo (1919) has pointed out, within recent years a considerable amount of work has been done on Myxosporidia in areas other than the European, especially in North America and Asia, there still remain great regions of the world in which practically no studies have been undertaken in this order. Until an attempt has been made to fill these gaps it will be impossible to make use of this peculiar group as fully as is to be desired. The apparently very uniform type of environment in which so many Myxosporidia live suggests that much interesting information regarding the evolution of the order might be revealed if more not only of the developmental cycles but also of the distribution were known. Certain areas in the Mediterranean Sea and on the American and European sides of the North Atlantic are reasonably well investigated, but the Southern Hemisphere and the Pacific Ocean are almost virgin fields. The former, owing perhaps to the comparative absence of large land masses with their accompanying numbers of scientific investigators, will probably remain for long a rather imperfectly explored field as far as Myxosporidia are concerned.

The North Pacific, on the other hand, affords an exceptionally interesting region for investigation. The long American coast on one side forms an excellent base for operations, while Japan and the Phillipine Islands on the other side and the Hawaiian Islands at the mid-way point make it possible to examine samples of fishes from all types of environment. An adequate study of this vast area might yield an extremely interesting body of facts. On the Japanese side there are a few records, notably Fujita's (1923) paper. From the Hawaiian Islands there seem to be no observations. From the American side of the Pacific we have only Jameson's (1929) paper. Much "spade work" is therefore necessary if even a brief survey of this important region is to be obtained.

During the summer of 1930 I was enabled to study a considerable number of fishes from Southern California waters at the laboratory of the Fish and Game Commission of California in San Pedro, and later I was allowed to examine fishes from the tanks of the Steinhardt

Aquarium in San Francisco. The results of these examinations are embodied in this paper. I am much indebted to Mr. Scofield, Director of the San Pedro laboratory for the hospitality he extended to me, and to various members of his staff, especially to Mr. Walford, for securing and identifying fish for me. To the Director, the Assistant Director and the staff of the Steinhardt Aquarium I am also very grateful for their unfailing kindness in providing me with material.

## MYXOSPORIDIA FROM SOUTHERN CALIFORNIA

South of Point Conception on the Californian coast there is a considerable change in the fish fauna as compared with the Monterey Bay region, which I had previously examined, and it was hoped that some new types of Myxosporidia might be encountered here. On the whole, however, there was a marked similarity between the two areas. In all twenty-four species of fish were examined of which six were forms that had been encountered in Monterey Bay so that on the whole a rather different series of hosts was investigated. Nine different species of Myxosporidia were found of which three are new species, four are species recorded from Monterey Bay and two are species previously reported from other parts of the world. As usual it was the flat-fish and the Elasmobranchs which are most commonly infected. Such characteristic southern fish as the Barracuda and the Tuna were not infected, possibly because they seem to be surface feeders and in such fish infection is rare. The following is the list of parasites found with the description of three new species.

### *Ceratomyxa fisheri* JAMESON

Habitat: Gall bladder of *Chromis punctipinnis.*

This species was previously reported from the Chimera, *Hydrolagus colliei.* As a rule Myxosporidia of the same species are found in hosts that are not very distantly related. Here, however, is a case of widely differing hosts. Nine out of twelve Chromis were heavily infected while four Hydrolagus examined from the same area had no trace of infection. The trophozoites differed somewhat from those observed in Monterey. In the original description it is noted that there seemed to be an absence of pseudopodia; in the San Pedro material pseudopodia of a rather long, sharply pointed type were found. The spores and nuclei corresponded exactly.

### *Ceratomyxa hopkinsi* JAMESON

Habitat: Gall bladder of *Parophrys vetulus* and *Orthopsetta xanthostigma.* This was previously reported from the first of these hosts. The second is a new host.

*Ceratomyxa taenia* NOV. SP. (Figs. 1-3)

Habitat: Gall bladder of *Triakis semifasciatus.*

Trophozoite. Regular oval in shape. No marked pseudopodia but the margin slightly undulated in places. No movement observed. Ectoplasm and endoplasm not clearly differentiated excepting that in the latter there are scattered, rather sparsely small, pale yellow granules. Disporous.

Spore. The valves are markedly unequal and their ends are drawn out into ribbon-like appendages. The curvature of the spore varies from nearly straight to strongly bent, in the latter case the spore has an odd appearance owing to the fact that the bend occurs at the suture line and therefore much nearer one end than the other. The cavity of the spore is large and is filled by the sporoplasm. The suture line is marked by a delicate ridge. The pole capsules are round and lie very close together. Size: Breadth 95 to 117$\mu$; suture line 7.5 to 9.5$\mu$.

Nucleus. The chromatin is concentrated in a peripheral karyosome giving a signet-ring effect. Named for the ribbon-like appendages of the spore.

*Ceratomyxa venusa* NOV. SP. (Figs. 4-6)

Habitat: Gall bladder of *Cynoscion nobilis.*

Trophozoite. Small in size and neat in appearance, round to oval, usually spherical but sometimes flattened. Remarkable for the presence in the cytoplasm of numerous round granules about 1$\mu$ in diameter. These granules are transparent and colorless and very constant in size and shape. They stain hardly at all with nuclear dyes but are slightly colored by cytoplasmic stains, such as acid fuchsin. They are crowded closely together and the cytoplasm is always filled with them. Such inclusions naturally suggest a reserve food supply but as they do not seem to be used up at any stage in the life of the trophozoite it is improbable that they can have this function. When the spores have been formed and are ready to break away from the trophozoite it is still packed with the granules, which appear to be released from the cytoplasm when it disintegrates at the end of its spore producing phase. It is possible that the granules are waste products. There is little or no differentiation in ectoplasm and endoplasm. Pseudopodia formation was not seen. Monosporous and disporous.

Spore. Delicate, thin-walled structures with long, slightly tapering valves. These are hollow but on account of the delicacy of the walls they are frequently collapsed in fixed specimens and they then appear ribbon-like. The sporoplasm is slightly asymmetrically placed in the central part of the spore and the space in which it lies seems to be separated by a very delicate membrane from the terminal portions of the valves. As the spores develop in the trophozoite they form a ring or two rings, according as the condition is mono- or dis-porous, round

the periphery of the sphere, the ends of the valves being doubled back and overlap behind the central portion. The ends of the valves are truncated. The pole capsules are prominent and rounded. The sporoplasm is granular but the granules are small and irregular and stain deeply with hematoxylin, quite unlike the granules of the trophozoite. Within the hollow valves are frequently found similar granules. Size: Breadth 63 to 78$\mu$; suture line 4 to 6$\mu$.

Nucleus. On account of the concentration of chromatin into a granular cap at one pole the nuclei are very prominent even in unstained specimens. The nucleus is not large but it is rich in chromatin which is present in the form of large grains.

*Chloromyxum ovatum* JAMESON

Habitat: Gall bladder of *Mustelus californicus* and *Rhinotriakis henlei*. Previously recorded from Monterey Bay and now found in two new hosts.

*Chloromyxum levigatum* NOV. SP. (Figs. 7-9)

Habitat: Gall bladder of Squatina californica.

Trophozoite. Small individuals were most common. These were round to oval with typically very blunt pseudopodia—a few with pointed pseudopodia were seen—formed from the abundant clear ectoplasm. The endoplasm was crowded with fine granules. These trophozoites only occasionally contained spores, and then only one or two. They were evidently young forms. A few larger specimens were found in which the pseudopodia were sharply pointed and rather long. In these the granules in the endoplasm were coarser but the ectoplasm was still abundant. These forms were all polysporous.

Spore. The most characteristic feature of the spore is the smooth rather thin wall. It is broadly ovate with the anterior end somewhat bluntly pointed. The pole capsules are long and narrow. The suture line while clear is not strongly developed. The sporoplasm is diffuse. Size: Length 11 to 13$\mu$; breadth 8 to 10$\mu$.

Nucleus. This is small but very definite. There is a prominent central granule and round the periphery are set close together many extremely small granules. It is the same type of nucleus as that of *C. leydigi*. This species is of the *leydigi* type as its nucleus and the general spore shape would indicate, but the absence of ridges on the valves and the posterior processes, along with the slender pole capsules are sufficiently important to warrant the creation of a new species.

It is surprising that the Elasmobranchs in the Pacific should not usually harbor *C. leydigi*, the species found in a great variety of these fishes from widely separated regions. This species has been recovered from one ray, *Tetronarce californica* (Jameson 1929) but the common species seems to be *C. ovatum*, and now another species has been

described. These three species are doubtless closely related but they are so distinct from one another that it seems better, at all events at present, to give them specific rank.

*Sphaerospora divergens* THÉLOHAN

Habitat: From the urinary bladder of *Pleuronichthys verticalis.*

My specimens corresponded very closely with Thélohan's (1895) description with the slight exception that the spores were slightly smaller, 8 to 10$\mu$ as against 10 to 12$\mu$. The nucleus is prominent with a limited number of coarse granules of chromatin round the periphery and no central granule. In the trophozoites a large peripheral karyosome, giving a signet ring effect was frequently noted.

*Myxidium incurvatum* THÉLOHAN

Habitat: Gall bladder of *Sebastodes carnatus* and *S. rhodochloris.*

This very common and widely distributed species occurred in Monterey Bay in *Sebastodes caurinus.*

MYXOSPORIDIA FROM STEINHARDT AQUARIUM

It was hoped that the numerous tropical fishes in this aquarium might yield some evidence regarding the Myxosporidia from the warmer parts of the Pacific Ocean, but as it was possible to obtain specimens only after the fish had died and as the death rate is very low in the tanks only seven specimens of tropical fish were examined, too few to be of any value. None of these was parasitized. A number of local fishes was obtained and these harbored some interesting forms which are described in the following pages.

*Ceratomyxa fisheri* JAMESON

Habitat: Gall bladder of *Rhacochilus toxotes* and *Halicheres semicinctus.*

The specimens found in these two hosts corresponded closely with the types already recorded. Those from Halicheres had spores that were rather wider on the suture line, being 8$\mu$ as compared with 5 to 7$\mu$ in the others. This species of Ceratomyxa has a wider range of hosts than most Myxosporidia, having now been reported from four different fishes within a comparatively limited area. Furthermore it seems to belong to a small group of species, which includes also *C. (Leptotheca) scissura* Davis and *C. (Leptotheca) limandae* Fujita, that are closely related. Possibly these three species on further investigation will be found to form but one widely ranging species.

*Ceratomyxa furcata* FUJITA

Habitat: Gall bladder of *Apodichthys flavidus.*

There is no doubt that the specimens I have found in this host belong to Fujita's (1923) species although the size of the spore is

not the same. Fujita's specimens are very much larger—each valve measuring up to 60$\mu$ in length, while my specimens do not measure more than 30$\mu$. The inequality of the valves which Fujita mentions in the text is not shown in his figures so one presumes that this is not a particularly constant feature.

It is interesting to note that another Japanese species, *C. tenuis* Fujita, which was found by me in a Californian fish (Jameson 1929) also showed a great difference in size while other features were alike. As Fujita found no species that had been previously described it is impossible to say that Japanese Myxosporidia are larger than similar forms from other regions, still it is perhaps significant that both of the Japanese species found in California were much smaller than the type specimens. On the whole, merely judging from the size range of all Fujita's species, one might say that the spores described by him tend to be large.

Fujita's note that "in the present form the configuration of the spore is its prominent characteristic, any similar case hitherto known being never yet found in other species of Ceratomyxa. Accordingly I consider this parasite as a new type of the genus" besides being a little bit cryptic is hardly justified. *C. furcata* is obviously nearly related to *C. arcuata* Thélohan the type species of the genus.

Trophozoite. Nothing very characteristic is to be seen in the vegetative form according to Fujita except the presence of densely packed granules in the young forms, gradually becoming less numerous in the older ones. In my specimens the granules were never very closely packed but were always prominent, being of rather a coarse type. Only monosporous forms were found. In the early stages of spore formation a prominent vacuole develops in the endoplasm and round this the ends of the spore are bent, giving a very striking appearance to the sporulating trophozoites.

Spores. Apart from the difference in size the spores of my specimens agree closely with Fujita's description. The softness of the spore case often causes the empty pointed ends to collapse and become deformed. Size: Breadth 20 to 30$\mu$; suture line 5 to 8$\mu$; valve measured from a tip to suture line 24 to 29$\mu$.

Nucleus. Small, with a few moderately sized chromatin granules round the periphery and one in the center.

### *Chloromyxum trijugum* KUDO

Habitat: Gall bladder of *Pomoxis sparoides*.

This species was first found in the gall bladder of *Lepomis megalopis* and is here reported from a member of the same family. *Pomoxis sparoides*—the Calico Bass—was introduced into Californian streams

some years ago and most probably it brought this parasite with it from the more eastern rivers.

Trophozoite. This closely resembles Kudo's (1919) description, being very variable in form and having the ectoplasm clearly marked off from the endoplasm. Although the specimens varied greatly in size only polysporous forms were found.

Spores. The spores in their main outlines were the same as Kudo's. The sutural ridge and the ridge on each side of this were very prominent but the short ridges running centrally from these were not marked. The pole capsules stand out very clearly and occupy a large part of the spore.

Nucleus. As shown in Kudo's figures, the nucleus is rather large but as the chromatin is concentrated in a central karyosome, the periphery having only a scattering of very tiny granules, it frequently appears at first sight as a very small nucleus, only the karyosome being observed.

*Chloromyxum ovatum* JAMESON

Habitat: Gall bladder of *Urolophus halleri.* A third new host record of a species already described from Monterey Bay.

THE GENUS SINUOLINEA

This genus is far from satisfactory. Three of its members resemble the genus Sphaerospora very closely. Indeed the only character that the spherical members of the genus Sinuolinea possess that is not present in some species of Sphaerospora is the sinuous suture line and that is hardly a sufficient ground for creating a new genus. Such a character is found in the genus Myxidium and is regarded as being of only specific worth. The divergent pole capsules are found in *S. divergens* Thélohan and the rounded pole capsules in *S. elegans* Thélohan. The type species of the genus, *S. dimorpha,* was first described by Davis (1916) as a species of the genus Sphaerospora and the genus Sinuolinea was later (Davis 1917) created for this species and a number of other forms. Of the five species described three, *S. dimorpha, S. capsularis* and *S. arborescens,* seem to me to be so closely allied to the genus Sphaerospora that there was no valid reason for putting them in a new genus.

If we remove the three spherical forms, placing them in the genus Sphaerospora, we are left with two species, *S. opacita* and *S. brachiophora,* which stand quite apart from the first three. Davis remarks with regard to *brachiophora* that "possibly this species should be made the type of a new genus" and that "in many respects [it is] very similar to *S. opacita.*" It is very certain that these two species have little in common with the three spherical species above discussed. Their affinities seem to be much closer to the genus Ceratomyxa but they

have certain characteristics distinct enough to warrant keeping them in a separate genus. The distinctive characters are first a clearly walled off, small spherical or oval central chamber in which the sporoplasm and pole capsules are located, and second a pair of prominent lateral appendages attached to this. The suture line is slightly curved but this is probably not of great importance. These characters of course apply to the spore, there being no vegetative characters of sufficient worth for diagnostic purposes. The genus Sinuolinea, defined by the two characteristic features noted above, would consist of what is left of the genus after the separation of the three Sphaerospora forms with possibly the addition of the species *Ceratomyxa spinosa* Davis 1917. There are several species of Ceratomyxa that have appendages to the valves but only *C. spinosa* has the clearly marked central chamber. It is of course very probable that the species we are referring to the genus Sinuolinea should be placed near such forms as *C. linospora* Doflein, *C. acadiensis* Mavor and other appendage bearing Ceratomyxa but the central chamber is so marked in the three forms named that we are probably justified in regarding them as belonging to a separate genus.

It is proposed, therefore, that the three species *S. dimorpha, S. capsularis* and *S. arborescens* should be placed in the genus Sphaerospora, while the two species *S. brachiophora* and *S. opacita* are retained in the genus Sinuolinea and the species *C. spinosa* is removed from the genus Ceratomyxa and placed in the genus Sinuolinea.

### *Sphaerospora dimorpha* DAVIS

Habitat: Urinary bladder of *Porichthys notatus.*

Trophozoite. Only small monosporous and disporous forms were found so that the characteristic polysporous type described by Davis was not examined. The specimens in my material were usually rather oval in shape with a single pseudopodium occasionally. The ectoplasm had a stringy appearance, as if it were very slightly ridged or folded. No erythrocytes were seen in the endoplasm.

Spore. Except in size this corresponded very closely with Davis's description. The curved suture line is very prominent and the large round pole capsules are characteristic. The size was considerably larger than that (15$\mu$) given by Davis, the diameter ranging from 16 to 19$\mu$.

Nucleus. Small with chromatin scanty in amount. Only a very few granules scattered round the periphery. This is a very different nucleus from that described so fully by Davis (1916), which has abundant chromatin and a large karyosome. It is possible that this striking difference indicates a specific difference, but our knowledge of

the Myxosporidian nucleus is so imperfect that it is impossible at present to use it as a character in classification. I feel compelled, therefore, to place my specimens in Davis's species with the warning that the forms under discussion are not a well differentiated group and await a further examination by someone who obtains a large amount of material adequately representing the various species. It might be pointed out that the type of nucleus described for *S. dimorpha* closely resembles a nuclear type found by me in *S. divergens* trophozoites so that while the differences indicated may be of specific importance they tend rather to support my view that the spherical members of Davis's genus Sinuolinea are really Sphaerospora.

*Sinuolinea bidens* NOV. SP. (Figs. 10-12)

Habitat: Urinary bladder of *Porichthys notatus.*

Trophozoite. Irregularly round to oval. No formation of pseudopodia observed. The ectoplasm is clear but not abundant. The endoplasm is very slightly granular. Disporous.

Spore. The central chamber is oval. The appendages, while very prominent, are relatively short. They are rounded in cross section and rather sharply pointed, projecting posteriorly like two fangs; hence the name. The suture line is strongly curved and clearly marked. The pole capsules are round and prominent. The sporoplasm usually fills the cavity of the spore. This spore is of the *opacita* type but it differs from it in the oval central chamber, the much larger appendages, the more strongly curved suture line and the absence of fat globules from the cytoplasm. Size: Central chamber 8 by 6.5 to 11.5 by 9$\mu$; appendages 6 to 10$\mu$.

Nucleus. Rather large with chromatin granules crowded round the periphery. Usually there is a small slightly excentric karyosome composed of about three larger particles.

*Sinuolinea cella* NOV. SP. (Figs. 13-14)

Habitat: Urinary bladder of *Porichthys notatus.*

No trophozoites were found; only numerous separate spores.

Spores. The central chamber is oval. The appendages are large, round in cross section, hollow and usually pointed at the ends, although at times forms with rounded ends were seen. The general outline of the spore is arc shaped, but the central chamber makes a very distinct break in the concavity of the arc. The wall between chamber and appendages while clearly marked is not thick. The suture line is prominent but only slightly curved. The rounded pole capsules while very evident are not particularly large. The sporoplasm is granular and does not completely fill the chamber. Size: Central chamber 9 by 8 to 13 by 10$\mu$; appendages 25 to 35$\mu$.

Nucleus. Strongly marked. Peripheral chromatin is present as well sized granules. There is also a central granule.

*Myxidium oviforme* PARISI

Habitat: Gall bladder of *Phanerodon furcatus* and *Salmo irideus.*

This species has already been recorded from *Phanerodon furcatus* in Monterey Bay. The occurrence in *Salmo irideus* is new. The latter host is of interest as it is a fresh water fish* while the other hosts, with one exception, are marine. The exception is *Salmo salar* which is anadromous.

## SUMMARY

1. Five new species of Myxosporidia are reported.

2. Thirteen species of Myxosporidia already described were found in new hosts.

3. The genus Sinuolinea is discussed and proposals are made for its revision.

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* As Professor Ward has pointed out to me the Rainbow Trout is the fresh water form of the anadromous Steelhead so that this case is perhaps the same as *Salmo salar.*

## EXPLANATION OF PLATE IV

Fig. 1.—*Ceratomyxa taenia,* spore, × 1000.
Fig. 2.—*C. taenia,* trophozoite, × 1000.
Fig. 3.—*C. taenia,* nuclei, × 1800.
Fig. 4.—*C. venusta,* spore, × 1800.
Fig. 5.—*C. venusta,* trophozoite with spores, × 1000.
Fig. 6.—*C. venusta,* trophozoite with nuclei and granules, × 1800.
Figs. 7, 8.—*Chloromyxum levigatum,* spore, × 1800.
Fig. 9.—*C. levigatum,* trophozoite, × 1800.
Fig. 10.—*Sinuolinea bidens,* trophozoite, ×1800.
Figs. 11, 12.—*S. bidens,* spore, × 1000.
Fig. 13.—*S. cella,* spore, × 1000.
Fig. 14.—*S. cella,* central part of spore, × 1800.

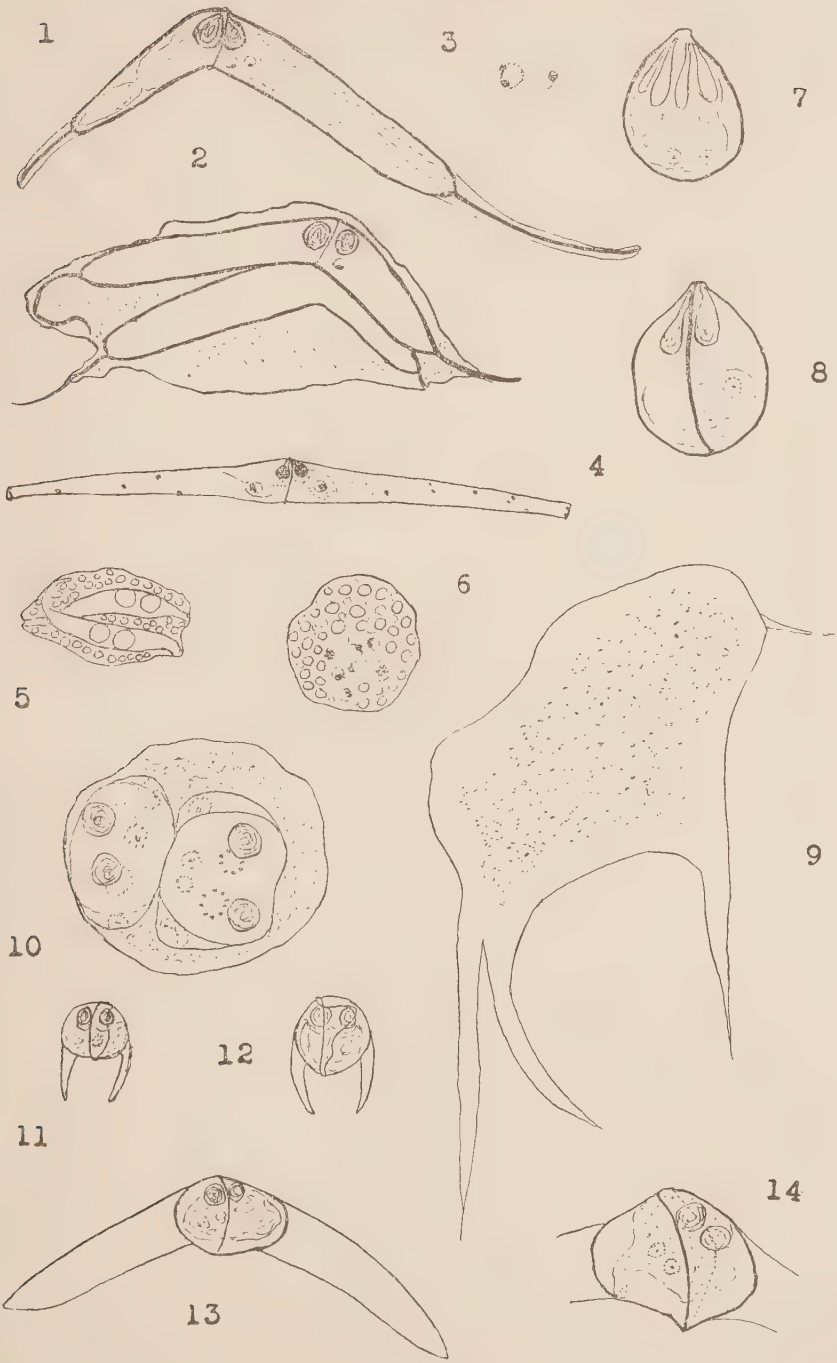


PLATE IV

# A NEW NORTH AMERICAN ASPIDOGASTRID, *LOPHOTASPIS INTERIORA**

Henry B. Ward and Sewell H. Hopkins

Among the digenetic trematodes the suborder Aspidocotylea attracts particular attention. The number of known forms is small, they vary considerably from each other as a rule, and the group appears in consequence, as a few, short series of widely separated species, each group of which deserves generic if not higher rank. Both in structure and in life cycle, these forms appear to be transitional between the monogenetic trematodes and the other digenetic groups. The discovery of a new form is thus of more than ordinary interest, a presumption that was fully realized in the present instance. Recently a flatworm belonging to this group was obtained at the zoological laboratory of the University of Illinois. The record of its discovery is as follows:—

An Alligator snapping turtle, male, weighing 103 pounds, was caught in a seine by a fishing party near Cord, Arkansas, in a small lake in the river bottom of the Black River. It was taken in October, 1930, and kept on exhibition in Macon, Illinois, for several weeks. During part of this time the turtle was fed fish and birds, and possibly other food, but during the latter part of its capitivity it refused to eat. On December 10, 1930, the turtle died and the next day was brought to the University. On December 12 it was dissected. About 250 large nematodes were found in the intestine. One Aspidogastrid was found in the small intestine just below the stomach. The turtle was in good condition, showing no signs of decomposition, and all the parasites were alive and active. The Aspidogastrid was put into a dish of salt solution where it sank to the bottom and secured such a strong hold on the glass that it could not be shaken loose, but had to be scraped off with a scalpel. Its general color was a brownish red; on the dorsal side was a wide strip of lighter color in the center, bordered on each side by bands of red. The worm was active, extending the body anterior to the ventral disc until it almost equaled the disc in length and waving it from side to side, sometimes bending the "neck" far back over the dorsal surface of the body. It was not seen to move forward or to use its mouth for holding on. The body of the Aspidogastrid turned white immediately on being killed in hot corrosive sublimate with acetic acid added.

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* Contribution from the Zoological Laboratory of the University of Illinois. No. 410.

The specimen was studied alive for some time, then carefully preserved after Looss' method and subjected to further examination after being cleared in oil of wintergreen. The structure could not be fully determined because of the opacity of the tissues. Since the specimen was unique, it was not sectioned but preserved entire. It is apparently a new species to which may be given the name

*Lophotaspis interiora* Ward and Hopkins

Total length about 3.94 mm, of which about 3.34 mm is covered by the ventral disc. The body proper consists of two parts: a flattened portion dorsal to the disc and a cylindrical extensile neck-like portion reaching anteriad (Figs. 1-4).

The ventral disc is an elongated oval in shape, 3.34 mm. long, 0.60 mm wide. It extends posteriad beyond the end of the body proper and anteriad beyond its point of attachment to the body. The width is almost twice the width of the body proper. The ventral disc contains 65 suckers (alveoli or loculi) arranged in four longitudinal rows. The two outside rows, which are continuous at the anterior and posterior ends, contain together 35 alveoli; the two inside rows together contain 30, making a total of 65. The alveoli of each row are arranged alternately with those of the next, so that they form diagonal rows across the body. All are oval in shape, with the long axis transverse, i. e. perpendicular to the long axis of the disc. The alveoli of the outside rows are somewhat larger than those in the median rows. There are 87 hollow, elongated papillae, each of which stands on the interlocular septum in a corner between 3 alveoli (Figs. 2, 8). They may be conceived as forming 3 double longitudinal rows. Around the entire outside margin of the disc, alternating with alveoli of the outside row, is a row of much smaller rounded papillae or marginal bodies.

The mouth is a sub-terminal transverse opening, of elongated oval form. The oral cavity is followed immediately by a large muscular pharynx which is about as long as the oral cavity is wide, but is deeper than the latter. The pharynx leads into an enlarged esophageal chamber almost as large as the pharynx, followed by the narrower undivided intestine, which reaches back a little past the testis. The testis is near the posterior end of the body ventral to the intestine; it is a large spherical organ lying in the median longitudinal axis of the body. The ovary is much smaller, its diameter being only about one-third that of the testis; it lies a short distance anterior to the testis and on the right side; it appears to be spherical. The uterus runs posteriad in coils to the level of the center of the testis and then anteriad in wide loops which reach the full width of the body, the coils passing over the intestine and then diagonally downward on each side of it. The genital pore is ventral, just behind the margin of the mouth. The full course

of the vas deferens cannot be traced, but it opens at the same place as the uterus and seems to be ventral to the intestine throughout its length. The worm is just attaining maturity and contains only three eggs, which measure about 130 by 50$\mu$. The vitellaria form two narrow bands on each side of the body, beginning about two-fifths of the body length from the anterior end and meeting behind the posterior end of the intestine, thus forming together a U-shaped band. They lie in the same horizontal plane as the intestine. The ootype and the shell glands lie between the ovary and the testis, but their exact structure cannot be traced with any certainty. Laurer's canal could not be seen, but this does not exclude its possible presence. The excretory pore is dorsal, just posterior to the end of the intestine; a bifid excretory bladder lies just below the dorsal surface. Nothing else could be seen of this system.

## PREVIOUS NORTH AMERICAN RECORDS

Only three genera of Aspidocotylea have been reported previously from freshwater hosts in North America, viz. Aspidogaster, Cotylaspis and Cotylogaster (Ward and Whipple, 1918). These genera all belong to the family Aspidogastridae Poche 1907, which indeed is the only family yet recognized in the suborder of the Aspidocotylea.

The early records of the Aspidogastridae were fully discussed by Stunkard (1917) so that these need not be reviewed here. He himself studied three species then known from North America, viz. *Aspidogaster conchicola* von Baer, *Cotylaspis insignis* Leidy and *Cotylaspis cokeri* Barker and Parsons. Since the appearance of Stunkard's monograph only one record has been printed of a new form in any North American fresh water host. Rumbold (1928) described *Cotylaspis stunkardi* n. sp. from the intestine of the snapping turtle, *Chelydra serpentina,* taken in the Eno River, Durham, N. C. This genus had been reported from a turtle in North America previously as Barker and Parsons (1914) described *Cotylaspis cokeri* from the intestine of *Malacoclemmys lesueurii,* altho the type species, *C. insignis* Leidy 1857, occurs in the mantle cavity of various species of Unionidae in North America. Simer (1929) found *C. cokeri* in Polyodon in the Tallahatchie River, Miss.

These are the only records thus far published of the occurrence in North America of an Aspidocotylean in reptiles. However, the species of Cotylaspis are clearly separated from the form under discussion here by the fact that in the ventral disc the alveoli stand in three longitudinal rows, the central alveoli being elongated transversely. This arrangement of the alveoli is characteristic of the genus Cotylaspis and together with numerous minor structural details serves to exclude the new form from that genus.

Another species from North American fresh water fish, namely, *Cotylogaster occidentalis,* originally described by Nickerson from the intestine of the sheepshead *Aplodinotus grunniens,* has recently been reported by Kelly (1926) from a new host. This host is the fresh-water clam *Lampsilis luteola.* The form newly discovered and described in this paper differs markedly from Cotylogaster. The genus Aspidogaster von Baer 1826 possesses a ventral shield made up of four rows of alveoli but the sucking grooves are quadrangular, the ventral disc carries no papillae and the internal structure differs from the new form in many details, especially the extent of the uterus and the presence of a cirrus pouch. Aspidogaster is the third and last of the genera previously reported from fresh water hosts in North America.

In the further search for species possibly related to the new form we came upon a parasite of marine turtles which demands consideration here. Stossich (1899) described as *Aspidogaster vallei* a species he found in the esophagus and stomach of a marine chelonian, *Thalassochelys caretta.* The specimens were secured at Corfu on May 23, 1898. In 1901 Looss published a brief account of the trematodes of marine Chelonia of the Egyptian coast. He described one form in the family Aspidogastridae under the name of *Lophotaspis adhaerens* n.g. n.sp. It was taken in numbers from the stomach of *Thalassochelys corticata.* In his later extended publication on the subject Looss (1902) recognized the identity of his specimens with those described earlier by Stossich and accordingly changed the name to *Lophotaspis vallei* (Stossich). In this paper Looss gave a detailed account of the parasite. This description agrees in general well with that of the form under discussion here; however numerous minor details justify regarding the latter at least as a separate species as we have done.

## OTHER SPECIES OF LOPHOTASPIS

At the close of his discussion Looss refers to a form of which the description was not accessible to him as being probably a related species. The account he mentioned was written by J. D. MacDonald (1876) on a parasite found in the respiratory siphon of a large Melo, or melon-shell, in Shark Bay, Western Australia. It was described only briefly and left unnamed; but from the data given and the drawings, Monticelli (1891) placed it in the genus Aspidogaster under the name of *A. macdonaldi.* Examination of the original paper shows that the parasite differs in some respects from Aspidogaster. The description is scanty to be sure but the illustrations leave little doubt; the species truly belongs in the genus Lophotaspis as Looss surmised.

Shipley and Hornell (1904) described a parasite of the pearl oyster under the name of *Aspidogaster margaritiferae* which also corresponds

in general appearance and structure to the forms hitherto noted. They speak especially of the papillae of the ventral shield and, tho calling them "tube feet," illustrate their distribution and action so as to show their similarity to the papillae of Lophotaspis. In our opinion this species also should be included in that genus and not in Aspidogaster.

The appended table gives comparative data on the four species of Lophotaspis, and the four of Aspidogaster which we believe should properly be included in those genera.

OTHER SPECIES LISTED AS ASPIDOGASTER

*A. ascidiae* Diesing 1858 (No adequate description, probably not even a trematode)

*A. cochleariformis* (Diesing 1838) Cobbold 1879 (lapsus for Aspidocotyle)

*A. elegans* (Olsson 1868) Monticelli 1891 = Macraspis

*A. insignis* (Leidy 1857) Braun 1893 = Cotylaspis

*A. lenoiri* Poirier 1886 = Platyaspis, later Cotylaspis

The data shown in the table are adequate to separate this new form from previously known species. If *L. interiora* be compared with *L. vallei* which is the only other well described species and also the only other mature specimen, then one notes first that *L. interiora* is much smaller both in total body size and in dimensions of the ventral disc. Other differences appear on more detailed study of the two forms. They are as follows:

*L. vallei* has 74 to 77 alveoli, *L. interiora* only 65. *L. vallei* has an undivided excretory bladder, while in *L. interiora* the excretory bladder is deeply bifid. In *L. vallei* the pharynx is much larger than the oral cavity and is much longer than wide, while in *L. interiora* the pharynx is approximately the same size as the oral cavity and nearly spherical. *L. vallei* occurs in marine turtles of the Mediterranean Sea while *L. interiora* was found in a fresh water turtle of the Mississippi Valley.

We know little about the distinguishing features of *L. macdonaldi* and *L. margaritiferae* but both of these species, even though the specimens described were still immature, possess more alveoli than our sexually mature specimen of *L. interiora* as appears clearly on examination of the figures given by MacDonald and by Shipley and Hornell. Unfortunately the descriptions given in both papers are too brief to be satisfying.

In certain respects the species included in the genus differ in structure. In *L. vallei,* the type species, Looss described the excretory pore as opening from a very small bladder like expansion which divided at once into two slender crura extending anteriad; in *L. interiora* the terminal bladder is clearly a bifid structure. The outline drawing of

*Comparative Data on Species*

| | Size in Mm. | Ventral Disc | Color | Papillae | Alveoli |
|---|---|---|---|---|---|
| *Lophotaspis vallei* (Stossich 1899) (syn. *Aspidogaster vallei* Stossich 1899, *Lophotaspis adhaerens* Looss 1901) | 9 × 1.5 | 6 × 1.5 | Dark flesh red | Evertible sacs, each at corner between three alveoli | Four rows; 41 in 2 outside rows, 36 in 2 inside rows, total 77 |
| *Lophotaspis margaritiferae* (Shipley & Hornell 1904) (Syn. *Aspidogaster margaritiferae* Shipley & Hornell 1904) | 6 mm. long | No data | Body brown-ochre, ventral shield rose-red | Hollow, invertible. Between outer and middle rows, and between two middle rows | Four rows, arranged alternately, about 20 in 2 outer rows, 18 in 2 inner rows |
| *Lophotaspis macdonaldi* (Monticelli 1892) (Syn "Little trematode" Macdonald 1876, *Aspidogaster macdonaldi* Monticelli 1892) | 2.5-3.2 (1/8-1/10 in.) | More than 2/3 length of body | "Tallowy white" | Retractile. At corners between alveoli 180 in all | Four rows, lateral ones largest 120 in all |
| *Lophotaspis interiora* Ward and Hopkins (this paper) | 3.9 × 0.6 | 3.34 × 0.6 | Brownish red in life, white in alcohol | Long, hollow. Each at corner between 3 alveoli, 87 in all | Four rows arranged alternately, 35 in 2 outer rows, 30 in 2 inner rows, 65 in all |
| *Aspidogaster conchicola* v. Baer 1826 (Data from Monticelli 1892, Stafford 1896) | 2½-3 × 1 | 3/4 length of body; as wide as body | Yellowish white | None | Four rows, crossed by straight transverse rows equal in size, quadrangular; 15 in each outer row, 16 in each inner row, 2 odd, total 64 (Monticelli) total up to 118 (Stafford) |
| *Aspidogaster limacoides* Diesing 1834 (Data from Voeltzkow 1888, Monticelli 1892) | 1-4 × 1.8-2 | 3/4 or more of body length, much wider than body, almost as wide as long 2.6 × 1.8 | Whitish | None | Four rows median large rectangles, lateral smaller, almost circular; 68 in all |
| *Aspidogaster ringens* Linton 1905 (Some data from MacCallum & MacCallum 1913) | 2.57 × 1.1 (Linton) 3.5 long (MacC. & MacC.) | 1.61 × 1.1 | Brownish red, ant end whitish, border ventral shield yellowish or translucent | None | Thirty-six in 2 marginal rows, almost circular; 16 or 17 transverse grooves divided by very weak median longitudinal ridge |
| *Aspidogaster kemostoma* MacCallum & MacCallum 1913 | 5-6 × 0.60 | 1.75 × 0.8 takes up little more than 2nd quarter of body | Not mentioned | None | Four rows, 14 or 15 quadrangular alveoli in each row |

*of Lophotaspis and Aspidogaster*

| Testis | Ovary | Uterus | Vitellaria | Eggs | Cirrus Sac | Host |
|---|---|---|---|---|---|---|
| Single, large, oval, occasionally indented. Ventral to intest. | Single, right, in front of testis, inverted U-shape | Thick regular transverse loops, dorsal to intest., ant. to testis | Single row on each side. Begin a little behind ant. end ventral shield, meet behind excretory pore | Long, yellow-brown, 130 to 138 by 42 to 46 $\mu$ | None | Marine turtles, *Thalassochelys corticata*, *T. caretta*, Mediterranean Sea |
| Single. Ventral to intest. | Single. Ventral to intestine | None distinguished. Genital pore posterior to pharynx | None distinguished | None (immature) | None mentioned | Pearl oyster, *Margaritifera vulgaris*, Ceylon |
| Not mentioned | Not mentioned | Not mentioned | Not mentioned | Not mentioned | Not mentioned | Melo or Melonshell, Shark Bay, Western Australia |
| Single, large, spherical, near posterior end, ventral to intestine | Single, small, right, in front of testis, ventral to intestine | Wide transverse loops dorsal to intestine, anterior to testis | Band of follicles not in single row, begin 2/5 body length from anterior end, meet at excretory pore | Long, elliptical, 130 by 50 $\mu$ | None | Fresh water turtle, *Macrochelys temminckii* (Holbrook), Arkansas |
| Single, ovoid or reniform, large as ovary. In center of ventral half | Single, ovoid with tapering small end, anterior to testis, right, as large as testis | Runs back past testis, then anteriorly | Follicles in two lateral longitudinal rows which do not converge | Long, elliptical, 96 to 127 by 60 $\mu$ | Present, long, pear-shaped, muscular | Unionidae, in Europe and N. America |
| Single, almost same size as ovary | Single, almost same size as testis | Not described | Follicles numerous, lateral, converging at anterior part of body | Ovoid, larger at one end than at other, 72 to 78 $\mu$ long | Present, short, small, flask-shaped | Fish, *Leuciscus idus*, *L. dobula*, Europe |
| Single, median, usually near middle of body, pear-shaped, ventral to intestine | Single, in front of testis, ventral to intestine | Runs back past testis, then anteriorly in many coils | Small, compact lobules, close together in lateral lines just dorsal to ventral shield | 103 by 58 $\mu$ (Linton) or 70 by 40 $\mu$ (Mac C & Mac C) | Muscular, thick-walled | Marine fish, *Micropogon undulatus*, *Trachinotus carolinus*, Atlantic coast of N. America |
| Single, large, elliptical, ventral near end of intestine | Single, pear-shaped, small end posterior, anterior to testis, ventral to intest. | Runs in coils past testis to posterior end of body, then coils toward anterior end | Widely separated lobules from middle of ventral shield nearly to posterior end of body | Elliptical, thick-walled, narrowed at one end, 70 by 50 $\mu$ | Present, cirrus muscular | Marine fish, *Trachinotus carolinus*, Atlantic coast of N. America |

the two organs elucidates the difference (Fig. 5). In *L. macdonaldi* the excretory system is unknown. In *L. margaritiferae* Shipley and Hornell describe the main features of the excretory system, but of the bladder they say only that the vessels open behind into "a contractile vesicle."

In both *L. vallei* and *L. interiora* the sexual ducts empty just behind the posterior ventral margin of the mouth whereas in *L. margaritiferae* a pore is vaguely indicated near the anterior margin of the ventral disc which may be the sexual orifice. In *L. macdonaldi* neither text nor illustrations give any indications of the location of the sexual pore.

## DISTRIBUTION AND HOSTS OF LOPHOTASPIS SPECIES

All previous records of the genus Lophotaspis indicated that it was a marine species. Furthermore the three records came from the warm waters of the Mediterranean, Ceylon and Western Australia. This new find locates it in freshwaters of the temperate zone.

The marine intermediate host was doubtless a bivalve as suggested by the report of Shipley and Hornell whose specimens, taken from the pearl oyster, were immature. Possibly MacDonald's specimen which came from the melon-shell was also an immature stage, but the description is too imperfect to justify drawing definite conclusions regarding this point.

The only specimens of Lophotaspis positively recognizable as adult came from marine turtles and were those described by Looss and Stossich from the Adriatic and Mediterranean seas. The specimen we studied was found in a chelonian, also, but in a species exclusively confined to freshwater. The parasite was probably a young adult as it contained three eggs. Altho the chance is remote one must keep in mind the possibility that this snapping turtle while in captivity may have been fed some marine oysters from the gulf and that the parasite was a marine species introduced thus adventitiously.

It is to be regretted that knowledge of the life history of the Aspidocotylea is so meager. In this group it appears most likely that significant data will be secured on the origin of the complex life cycle of Trematoda, especially the acquisition of a second host. A careful study of this group would certainly yield material of value but even the review of known facts concerning the two genera Aspidogaster and Lophotaspis suggests relations that are interesting. With the exception possibly of the case just reported Lophotaspis is exclusively marine; young stages are found in mollusks and adults in mollusk eating marine reptiles, perhaps also in mollusks.

Aspidogaster originally regarded as a fresh water species parasitic in European mussels is represented also by species occurring in fish. Other species of the genus have also been reported in North America from marine fish. As adults of species in the same genus are reported

both from mollusks and from fish, this condition suggests that mollusks fill the role of both intermediate and final hosts. Thus *A. conchicola* is reported in Europe from Unionidae and *A. limacoides* from fresh water fish, *Leuciscus idus, L. cephalus* and the carp. The two parasites are regarded by many investigators as the same species and in any event are very closely related. Similar cases are found in other genera of the Aspidogastridae; *Cotylaspis insignis* occurs in North American Unionidae and both *C. cokeri* and *C. stunkardi* in North American fresh water turtles. *Cotylogaster occidentalis* has been found in both Unionidae and fresh water fish in the Mississippi Valley. Such a relation shows the possible transition from the monogenetic type with a single host in the life history to the digenetic type utilizing at least two hosts in the life cycle.

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## Explanation of Plate

### PLATE V

All figures of *Lophotaspis interiora* and from camera drawings in outline.
Scale line in figures 1 to 4 represents 1 mm., in figures 6 to 8, 0.1 mm.

Fig. 1.—Ventral view to show character of disc.
Fig. 2.—Lateral view.

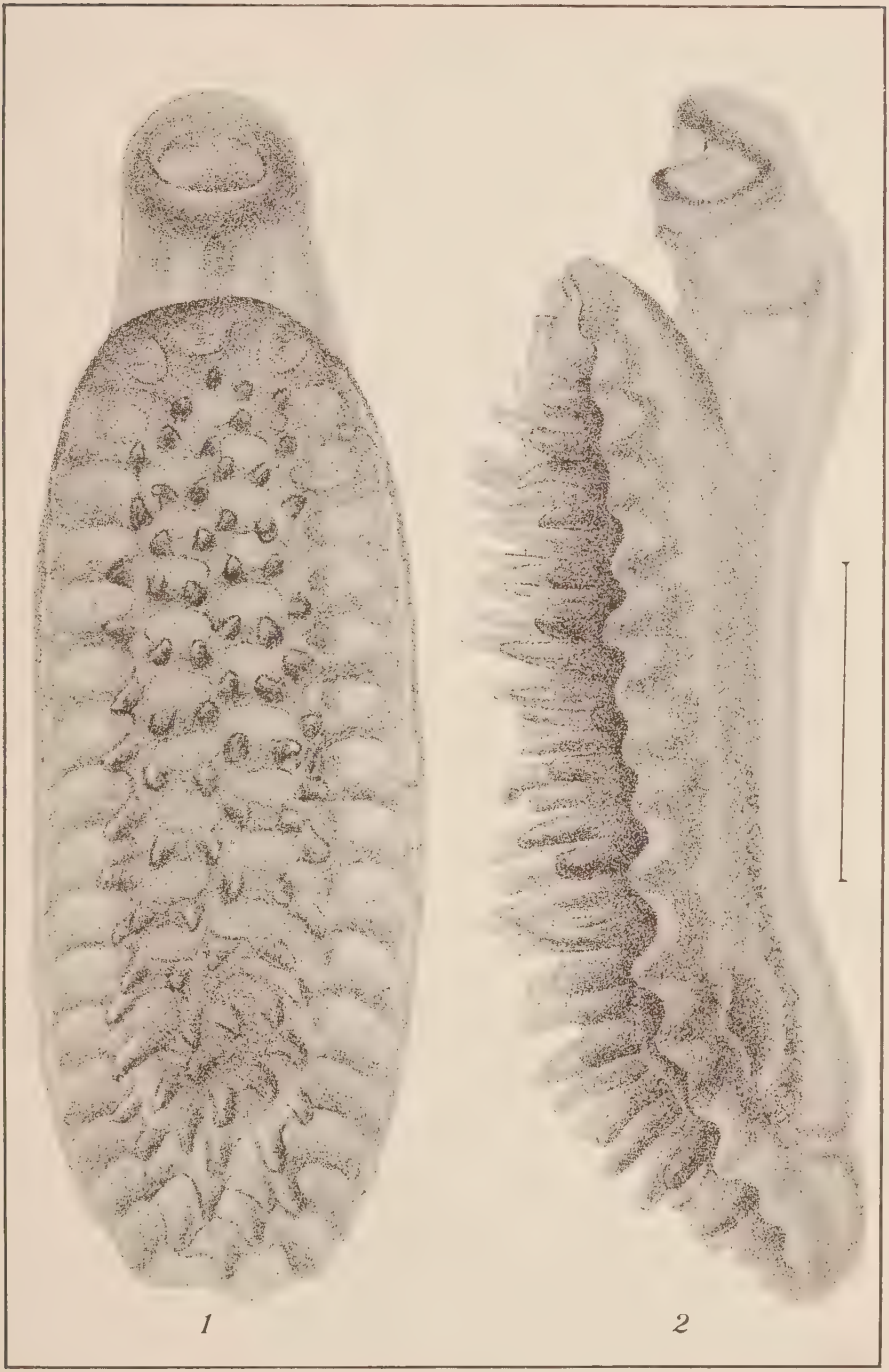


PLATE V

## Explanation of Plate

### PLATE VI

Fig. 3.—Dorsal view, showing as much of internal structure as could be clearly seen.

Fig. 4.—Lateral view. Uterus partly schematic, as more loops are present than could be seen clearly enough to draw.

Fig. 5.—Diagrammatic outline of excretory bladder (*a*) in *L. vallei*, (*b*) in *L. interiora*. Free hand sketch.

Fig. 6.—Lateral view of margin of ventral disc, showing small marginal papillae in interalveolar septa.

Fig. 7.—Outline drawing of two intrauterine eggs.

Fig. 8.—Papillae of central region of ventral disc.

### Abbreviations Used

*e*, egg in uterus
*eb*, excretory bladder
*ex*, excretory pore
*m*, *marginal bodies*
*o*, ovary
*p*, sex pore
*t*, testis
*u*, uterus
*v*, vitellaria
*vd*, vas deferens

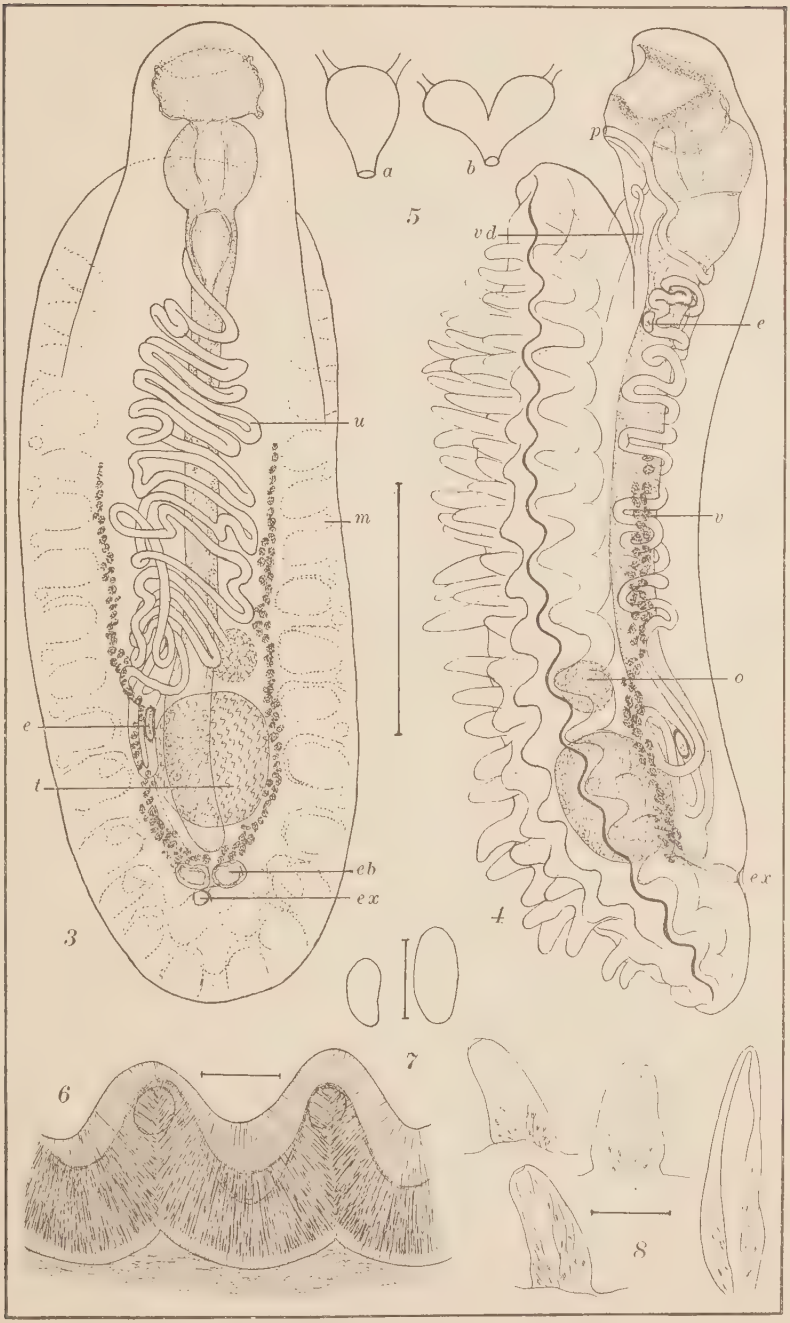


PLATE VI

# STUDIES ON CREPIDOSTOMUM. II. THE "*CREPIDOSTOMUM LAUREATUM*" OF A. R. COOPER*

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Specimens of Crepidostomum from *Perca flavescens, Eupomotis gibbosus, Boleosoma nigrum,* and *Etheostoma iowae* were described briefly by Cooper (1915) under the name of *Crepidostomum laureatum* (Zeder). Metacercariae from cysts in nymphs of *Hexagenia* sp. were also described in the same paper, and assigned to the same species. Cooper's specimens, with the exception of the single specimen from *Etheostoma iowae,* are now in the collection of Prof. Henry B. Ward, and through his kindness I have had the opportunity of studying them. The first fact brought out by this study is that none of Cooper's material can be attributed to *C. laureatum,* with the possible but improbable exception of the immature specimens from Eupomotis. Secondly, it was found that the specimens from *Perca flavescens* and those from *Boleosoma nigrum* represent each a distinct new species; the former is described below as *Crepidostomum cooperi* n. sp. and the latter as *Crepidostomum canadense* n. sp.

## *Crepidostomum cooperi* N. SP.

This species is represented by ten specimens collected by A. R. Cooper, June 15, 1912, from the intestine of *Perca flavescens* at Go-Home Bay, Ontario, and described by him in 1915 as *Crepidostomum laureatum* (Zeder). These specimens were poorly preserved even at the time Cooper studied them, as noted in his paper; and having been kept in cedar oil ever since, they are now in even worse condition, being almost impossible to stain. The mature specimens range from 0.39 to 0.86 mm. in length, the single immature specimen being only 0.24 mm. long. In all these specimens the post-acetabular part of the body is very thick, the greatest thickness or depth being about two-thirds of the greatest width (depth, 0.19; width, 0.27 in type specimen), while the pre-acetabular portion is much thinner and the depth is about half the width (depth at genital pore, 0.12; width, 0.21 in type specimen). This species clearly differs from *C. laureatum* in having the genital pore ventral to or posterior to the crural fork, and the cirrus pouch bending over the dorsal side of the acetabulum so that its posterior end lies close to the ventral surface of the body behind the acetabulum.

* Contribution from the Zoological Laboratory of the University of Illinois, under the direction of Henry B. Ward, No. 411.

The anterior end is armed with the usual six oral papillae: one pair ventral and lateral, one pair dorso-lateral, and the third pair median dorsal. The ventral pair fold over the ventral surface of the oral sucker, slightly overlapping the anterior margins of the oral orifice, and extend laterally from the ventral side of the sucker; in the type specimen they extend 40$\mu$ beyond the lateral edges of the sucker. The other two pairs of papillae are approximately the same size; in the type specimen they extend 30 to 40$\mu$ beyond the anterior margin of the sucker as seen in ventral view and are about 50$\mu$ wide. They are rounded at the ends when observed in ventral view, but pointed when seen in lateral view. At the base they are about 40$\mu$ thick in sagittal section. None show any indication of a notch in the tip. The muscle fibers in the papillae are not continuous with those of the sucker, but are almost perpendicular to them (fig. 5).

Cooper states that the oral sucker is larger than the ventral in these specimens; but his table shows that he apparently did not measure the suckers of the perch parasites, his conclusions being drawn from the specimens from Boleosoma and Etheostoma. In the perch specimens the two suckers are very nearly equal in size, but the ventral sucker is slightly larger than the oral in so far as measurable differences exist. In the type specimen (Fig. 2) the oral sucker measures 0.15 mm. in length and the same in width, while the ventral sucker is 0.16 mm. in both diameters. In the smallest mature specimen (Fig. 6) the oral sucker is 0.07 mm. long by 0.08 mm. wide, and the ventral sucker 0.06 by 0.09 mm. The distance from anterior end to ventral sucker is about one-third of the body length.

From the oral sucker a very short prepharynx, visible only in sections, leads to a broad barrel-shaped pharynx which in some specimens is nearly spherical. In the type specimen the pharynx is 60$\mu$ long by 50$\mu$ wide, and 50$\mu$ thick dorso-ventrally. A short esophagus, which presumably may be considerably longer in extended specimens, joins the crural fork a short distance in front of the ventral sucker and close to the dorsal surface. The crura run back close to the dorsal surface and bend inward behind the posterior testis, ending about half-way between the posterior margin of the testis and the posterior end of the body.

From the genital pore, which is just in front of the acetabulum and ventral to or a little behind the crural fork, the large cirrus pouch runs back over the dorsal side of the acetabulum and then bends down so that the broader posterior end lies close to the ventral surface of the body just behind the sucker.

The roughly spherical ovary lies close to the dorsal surface just behind the acetabulum, its anterior edge being dorsal to the posterior edge of the acetabulum, while its posterior edge lies in the same trans-

verse plane as the posterior end of the cirrus pouch. The seminal receptacle lies on the median side of the ovary, but posterior to it. The course of the uterus cannot be traced with certainty, but the eggs all lie in the space between the acetabulum and the anterior testis. They measure 50 to 60$\mu$ by 30 to 40$\mu$ and are 4 to 7 in number in the specimens at hand.

The large testes, almost spherical in the type specimen, lie close to the ventral surface in a median tandem position; in all the specimens studied they are so close together that the proximal edges touch or overlap. They are not irregular in outline as stared by Cooper, but have unusually smooth outlines as shown in my figures. In the type specimen the anterior testis is 0.13 by 0.13 mm. and the posterior testis 0.15 by 0.15 mm., as seen in frontal view, their depths being 0.12 mm. and 0.10 mm. respectively. The posterior testis is flattened irregularly by the pressure of the excretory bladder which lies just above it. The testes lie closer to the posterior end than in any other species of Crepidostomum, the distance from the posterior edge of the posterior testis to the posterior end being one-tenth to one-eighth of the total body length; the same measurement ranges from one-seventh to one-third of the body length in all other species except *C. cornutum,* in which it sometimes equals one-ninth, and *C. metoecus,* in which it is about one-eighth in Braun's figure. However, in *C. cornutum,* due to the smaller relative size of the testes and the fact that the anterior testis is often some distance in front of the posterior, one does not get the impression that the testes are crowded back into the posterior end as in *C. cooperi* which resembles *C. metoecus* more than any other species.

The vitellaria extend from the pharynx to the posterior end of the body. The follicles, which are unusually large, surround the intestinal crura on all except the dorsal side, only a few follicles being dorsal to the intestine; follicles extend into the intercrural space in the acetabular region and in front of the testes, and meet in the median line behind the testes in the type specimen. The vitelline ducts from the two sides meet just dorsal to the anterior edge of the anterior testis. Laurer's canal is present.

The excretory bladder opens by a terminal pore and extends over the testes to the anterior edge of the anterior testis. Scattered eyespots are located on each side of the esophagus; in the type specimen the pigment granules are scattered over a large area, and in some specimens I was unable to see eye spots.

The following is a brief specific diagnosis of *C. cooperi*:

Length of mature specimens, 0.39 to 0.86 mm. or possibly more; width, about one-third of length, greatest in region of ovary. Six oral papillae about equal in size, rounded at tips, extending beyond rim of oral sucker; none bifurcate or notched. Suckers large, diameters about

one-fifth of body length; ventral sucker slightly larger than oral. Distance from anterior end to ventral sucker about one-third of body length. Pharynx nearly spherical; length, one-third to one-half of diameter of oral sucker. Esophagus short, crural fork a short distance in front of ventral sucker, crura ending about halfway between posterior testis and posterior end of body. Genital pore median, ventral or posterior to crural fork and immediately in front of acetabulum. Cirrus pouch long, posterior end close to ventral surface behind ventral sucker and beside the ovary. Ovary approximately spherical, dorsal to posterior edge of ventral sucker and on either side. Testes large, almost spherical, close together near posterior end of body, median tandem. Eggs 50 to 60$\mu$ by 30 to 40$\mu$, few in number, confined to space between ventral sucker and anterior testis. Vitellaria from pharynx to posterior end; follicles large; mostly ventral to crura; overlapping or nearly overlapping behind testes. Excretory bladder reaching to anterior margin of anterior testis. Eyespots lateral to esophagus on each side, scattered in larger specimens.

*Crepidostomum canadense* N. SP.

This species is represented by six specimens from *Boleosoma nigrum*, the Johnny darter, collected by A. R. Cooper, August 15 and 19, 1911, at Go-Home Bay and described by him as *Crepidostomum laureatum* in his 1915 paper. Four of these are partly or completely broken in two. They have been in cedar oil ever since Cooper studied them, and could not be stained satisfactorily. I did not attempt to section them because of their extreme brittleness, and so my observations, like Cooper's, were made from unstained specimens in cedar oil under a cover slip. Because of this it was impossible to trace out all structures with certainty, but enough could be seen to show that this material represents a species distinct from *C. cooperi* and all previously described species of Crepidostomum.

The largest specimen in this lot, which is my type specimen, is evidently the same individual from which Cooper made his Figure 14, although since then it has been broken just anterior to the acetabulum. My drawing (Fig. 3) was made by putting the two pieces together. As I have reconstructed it, the specimen is 1.27 mm. long, while Cooper gives 1.20 mm. as his measurement, so it is improbable that any material was lost at the break or that the proportions shown are erroneous. (All my measurements of Cooper's material are somewhat larger than Cooper's measurements). The type specimen is 0.26 mm. wide at the point of greatest width, in the region of the testes. The oral sucker is 0.14 by 0.13 mm. in diameter, the ventral sucker 0.13 by 0.12 mm. The six oral papillae, approximately equal in size, closely resemble those of *C. cooperi* and *C. isostomum* in shape and arrangement, but are

smaller than those of *C. isostomum,* being only about 40μ long. The barrel-shaped pharynx measures 50 by 50μ in the type, but is noticeably longer than wide in two other specimens. It is closely applied to the posterior edge of the oral sucker, but a short pre-pharynx connects it with the oral orifice. The esophagus is several times the length of the pharynx, the intestine forking at a point dorsal to the center of the acetabulum, or even farther back. The crura run close to the dorsal surface, but not as near the lateral margins of the body as in other species, and end at a point about one-half or two-thirds the distance from the posterior testis to the posterior end of the body.

From the genital pore, which is a short distance behind the pharynx and two to four times as far anterior to the crural fork, the cirrus pouch appears to extend back to about the center of the acetabulum, but its exact shape and extent could not be determined with absolute certainty because of the condition of the specimens. The approximately spherical or ovoid ovary lies close behind the acetabulum, and in the type specimen, at least, the seminal receptacle lies just behind the ovary. The testes, which are rather small in proportion to the size of the body, lie close together in a somewhat oblique position some distance posterior to the ovary, the posterior testis being about halfway between the acetabulum and the posterior end of the body. Three specimens contain a single egg each, but in one case the egg is immature and in another it is turned on end. The only measurable egg is that of the type specimen, which is about 90 by 50μ. The vitellaria do not extend to the pharynx, but reach from the level of the genital pore almost to the posterior end of the body, surrounding the crura on all except the dorsal side, overlapping behind the testes and extending inward almost to the median line of the body between the testes and at the ovary.

The extent of the excretory bladder could not be determined with certainty, but in two specimens it apparently reached to the posterior edge of the ovary. Two distinct eyespots are located one on each side of the pharynx. In the type specimen the pigment granules are beginning to scatter to some extent.

A brief diagnosis of *Crepidostomum canadense* follows:

Length of mature specimens 0.7 to 1.3 mm., probably sometimes longer. Breadth about one-fourth length. Pre-acetabular portion slender, neck-like; body constricted at acetabulum, then widening to region of testes and tapering from here to posterior end. Oral papillae six, equal, rounded at tip; none notched or indented. Suckers nearly equal but oral sucker slightly larger; both spherical or nearly so; diameter of oral sucker approximately one-ninth, and of ventral sucker approximately one-tenth, length of body. Ventral sucker a little less than one-third of body length from anterior end in preserved specimens.

Pharynx spherical to elliptical; length one-third to one-half diameter of oral sucker. Pre-pharynx present but difficult to see in preserved specimens. Esophagus two to four times length of pharynx. Forking of intestine from center to posterior margin of ventral sucker, close to dorsal surface, crura running to about two-thirds the distance from posterior testis to posterior end of body. Testes small, somewhat oblique, close to ventral surface. Ovary spherical to ovoid, smaller than testes, close behind ventral sucker and dorsal; lateral or median. Cirrus pouch reaching back only to center of acetabulum (?). Genital pore median, ventral, one-fifth to one-third of way back from pharynx to crural fork. Vitellaria surrounding intestinal crura except on dorsal side, over-lapping behind testes, extending from genital pore almost to posterior end. Excretory bladder extending to posterior margin of ovary (?). Eggs about 90 by 50$\mu$, probably never numerous. Eyespots distinct, one on each side of pharynx.

The three immature specimens of this species in Cooper's collection are 0.28, 0.47, and 0.55 mm. long, respectively. In all of these the oral sucker is slightly larger than the ventral sucker; the intestine forks dorsal to the acetabulum; and the testes are obliquely placed. In one of them glands on each side of the esophagus, such as Brown (1927) describes in *C. laureatum,* could be seen indistinctly. The measurements given by Cooper lead one to suspect that the lost specimen from *Etheostoma iowae* was of the same species as the specimens from Boleosoma, but, of course, this cannot be stated as certain.

Another lot of specimens, which cannot be assigned to any known species and which are distinctly different from *C. laureatum* in several important features, consists of six specimens collected by Cooper from the intestine of *Eupomotis gibbosus,* Go-Home Bay, Ontario, August 22, 1911, and listed by Cooper (1915) as *Crepidostomum laureatum.*

All of these specimens are immature, and are treated separately as undetermined because of the difficulty in determining diagnostic characters with certainty in immature specimens, especially when so poorly preserved as these.

In Cooper's (1915) paper he described metacercariae from cysts in Hexagenia nymphs, which he supposed to be larvae of *Crepidostomum laureatum.* Frontal sections of two of Cooper's Crepidostomum metacercariae are in the Ward collection. The larger of these is 0.36 mm. long and the smaller 0.19 mm. They bear very little resemblance to the young metacercariae of *C. laureatum* as figured and described by Brown (1927), and are much smaller—in fact, much smaller even than the cercaria of *C. laureatum,* whose measurements Brown gives as 0.40 to 0.65 mm. by 0.13 to 0.24 mm. Furthermore, the oral papillae are much more prominent than in Brown's figures, and the oral sucker is

noticeably larger than the ventral. In view of the above facts it is almost certain that Cooper's metacercariae are not the young of *Crepidostomum laureatum*. The most probable surmise is that they are the metacercariae of *C. canadense*, but this theory must await evidence from the study of fresh material and experimental work.

In addition to the specimens listed by Cooper (1915) as *Crepidostomum laureatum*, I have found in Cooper's collection a vial containing ten specimens of a new species of Crepidostomum, together with specimens of *Crepidostomum cornutum* and *Cryptogonimus chyli*, from the pyloric ceca of *Ambloplites rupestris*, the rock bass, Go-Home Bay, Ontario, June 8, 1912. These specimens were killed in glacial acetic acid and preserved in 70% alcohol, and were in good condition when found. My study was made from whole mounts of specimens stained with Ehrlich's hematoxylin. This species is described below under the name of

*Crepidostomum ambloplitis* N. SP.

The 10 specimens studied range from 0.52 to 0.88 mm. in length. All are mature in the sense that they contain eggs. The breadth ranges from 0.10 to 0.17 mm. The body is of almost uniform breadth from the acetabulum to the posterior testis, tapering gradually from these limits to the ends, but the breadth at the acetabulum is slightly greater than elsewhere. The oral sucker is tilted up at an angle with the body so that the orifice is directed anteriorly as well as ventrally; the sucker itself, as well as the orifice, is longer than wide. The ventral sucker is slightly but distinctly smaller. The average dimensions for the 10 specimens are 95 by 88$\mu$ for the oral sucker and 84 by 81$\mu$ for the ventral sucker. In the type specimen the oral sucker is 120 by 110$\mu$ and the ventral 100 by 100$\mu$. The distance from the anterior end to the ventral sucker is one-third to one-half of the body length.

The oral papillae are quite characteristic in form and arrangement. The ventral papillae, which are considerably larger than the others, extend straight out laterally from the sides of the sucker. The thickness of these two papillae is less than the width. The other two pair are distinctly dorsal, though the two outside papillae project in a latero-dorsal direction; the median pair point straight up. All four dorsal papillae are round in cross section and have knob-like tips; they are attached to the sucker close to the middle of its dorsal surface, and do not reach to the anterior margin of the sucker as in other species. The ventral papillae do not overlap the ventral surface of the sucker. The length of the dorsal papillae is 20 to 30$\mu$ and of the ventral papillae about 40$\mu$, measured from point of attachment to tip.

The small barrel-shaped pharynx is in contact with the oral sucker but nevertheless is connected with the mouth by a short pre-pharynx.

The slender, sometimes convoluted, esophagus is two or three times the length of the pharynx; the crural fork is at a point one-half to three-fourths the distance from the posterior end of the pharynx to the anterior margin of the ventral sucker. The crura run back on each side of the acetabulum and end about half-way between the posterior testis and the posterior extremity of the body.

The genital pore is between the crural fork and the anterior margin of the acetabulum, or sometimes ventral to the crural fork, but never anterior to it. The slender elongated cirrus pouch tapers from near the posterior end to the anterior end; it lies dorsal to the acetabulum and curves around over the latter; the posterior end lies close to the ventral surface behind the acetabulum. The ovary lies beside the posterior end of the cirrus sac on either the right or the left side, and is nearer to the dorsal surface than to the ventral; it is about two-thirds the size of the testes. The irregularly shaped seminal receptacle lies close beside or behind the ovary. The vitelline ducts meet between the seminal receptacle and the anterior testis. The eggs are broadly ovoid, number 1 to 7 in the specimens at hand, and are 50 to 60$\mu$ by 30 to 40$\mu$, the average being 54 by 36$\mu$; some overlap the anterior edge of the anterior testis a little but none are wholly posterior to the anterior edge. The irregularly shaped testes, sometimes slightly indented or lobed, lie close to the ventral surface in a median tandem position. In all specimens they lie close together and in some cases they touch. The distance from the posterior margin of the posterior testis to the posterior end of the body is one-fifth to one-seventh of the body length.

The vitellaria extend from about halfway between the genital pore and the oral sucker almost to the posterior end, lying in the space between the crura and the margins of the body, and also ventral to the crura; they extend inward almost to the median line anterior to the acetabulum and between the testes, and overlap behind the posterior testis. The majority of the follicles lie in the ventral half of the body.

The excretory bladder is a narrow tube posterior to the testes, but the anterior end is enlarged; it reaches to the anterior margin of the anterior testis or slightly beyond. The excretory pore is terminal or slightly subterminal. Lateral to the pharynx or a short distance behind it on either side are two eyespots of dark brown pigment, always compact and of oval form. (Figs. 1, 8).

A brief specific diagnosis of *Crepidostomum ambloplitis* follows:

Length of mature specimens 0.5 to 0.9 mm., perhaps sometimes more. Breadth 0.10 to 0.17 mm. usually about one-fifth length. Greatest breadth at acetabulum. Oral sucker tilted at angle with body. Oral papillae small; dorsal papillae rounded, knob-like, attached halfway back on sucker, usually not extending to anterior margin; ventral papillae flattened dorso-ventrally, extending lateral from sides of sucker,

not overlapping oral orifice or ventral face of sucker; two ventral papillae distinctly larger than four dorsal papillae. Ventral sucker smaller than oral; diameter of former about one-eighth of body length, of latter, one-seventh. Ventral sucker one-third to one-half way back on body. Pharynx small, barrel-shaped, length one-third to two-fifths diameter of oral sucker. Esophagus two to three times length of pharynx. Crural fork some distance anterior to ventral sucker. Genital pore ventral or posterior to crural fork, never anterior. Cirrus pouch slender, tapering to anterior end, extending back of ventral sucker to ovary. Ovary dorsal, close behind ventral sucker, about two-thirds size of testes. Eggs averaging 54 by 36μ, few in number. Testes irregular in shape, ventral, close together, median tandem. Vitellaria ventral and lateral to crura from a short distance behind pharynx almost to posterior end, extending inward almost to median line anterior to the acetabulum and between the testes and overlapping behind the testes. Excretory bladder reaching to anterior edge of anterior testis or slightly beyond. Eyespots oval, compact, one on each side of esophagus or posterior end of pharynx.

KEY TO SPECIES OF CREPIDOSTOMUM AND RELATED GENERA

1 (2) Four testes, or two testes each divided into two completely separated lobes.....*Megalogonia ictaluri* Surber 1928

2 (1) Two testes, both entire ..... 3

3 (4) Oral papillae only two in number.....*Creptotrema creptotrema* Travassos, Artigas and Pereira 1928

4 (3) Oral papillae six in number ..... 5

5 (18) Genital pore posterior or ventral, never anterior, to crural fork..... 6

6 (9) Cirrus with thick muscular walls; cirrus sac stout..... 7

7 (8) Oral sucker conspicuously larger than ventral sucker; uterus sometimes extending posterior to anterior testis.....*Acrolichanus petalosus* (Lander 1902) Ward 1917 (Species name first published in Looss, 1902:454.)

8 (7) Oral sucker about equal to ventral sucker or slightly smaller; uterus not extending past anterior margin of anterior testis.....*Crepidostomum auriculatum* (Wedl 1857) Lühe 1909

9 (6) Cirrus without thick muscular walls; cirrus sac slender..... 10

10 (15) Oral sucker conspicuously larger than ventral sucker..... 11

11 (12) Oral papillae of median dorsal pair notched or bifurcate.....*Crepidostomum illinoisense* Faust 1918

12 (11) No oral papillae notched or bifurcate..... 13

13 (14) Oral papillae of two dorsal pairs short, not usually reaching past anterior margin of oral sucker; length of pharynx one-third to two-fifths diameter of oral sucker; eggs, 50-60μ by 30-40μ.....*Crepidostomum amblophtis* Hopkins (this paper)

14 (13) Oral papillae all large, two dorsal pairs extending well past anterior margin of oral sucker; length of pharynx one-fifth to one-third diameter of oral sucker; eggs 65 to 75μ by 40 to 50μ.....*Crepidostomum cornutum* (Osborn 1903) Stafford 1904

15 (10) Oral sucker smaller than ventral sucker, or suckers equal..... 16

16 (17) Ovary posterior to ventral sucker; diameter of suckers about one-tenth to one-eighth of body length in preserved specimens; in bats, Europe.....*Crepidostomum metoecus* Braun 1900

17 (16) Ovary dorsal to posterior edge of ventral sucker; diameter of suckers about one-fifth of body length in preserved specimens; in fish, North America.....*Crepidostomum cooperi* Hopkins (this paper)

18 (5) Genital pore distinctly anterior to crural fork..... 19

19 (22) Oral sucker conspicuously smaller than ventral sucker..... 20

20 (21) Vitellaria in rows along median side of each intestinal cecum posterior to testes; length of mature specimens 1.1-1.4 mm.; testes small, round...*Crepidostomum vitellobum* (Faust 1918) Hopkins (this paper)

21 (20) Vitellaria occupying all of intercrural space posterior to testes; length of mature specimens 1.5 to 6.0 mm.; testes large, often irregular in shape.....*Crepidostomum laureatum* (Zeder 1800) Braun 1900

22 (19) Oral Sucker not smaller than ventral sucker..... 23

23 (24) Oral sucker larger than ventral sucker; vitellaria overlapping behind testes.....*Crepidostomum canadense* Hopkins (this paper)

24 (23) Suckers equal; vitellaria not overlapping behind testes..... .....*Crepidostomum isostomum* Hopkins 1931

In this key to the Allocreadiidae which possess oral papillae, *Acrolichanus petalosus* is retained in a separate genus only because the uterus in some specimens extends posterior to the anterior testis, contrary to the condition in Crepidostomum. Skworzoff's (1927) detailed study of the *D. auriculatum* of Wedl shows that this species has the characteristics of a true Crepidostomum, but has some features in common with Acrolichanus—i. e., the position of the ventral pair of oral papillae, the stout cirrus sac, and the thick muscular walls of the cirrus. *C. isostomum* also has a stout cirrus sac, and the walls of the cirrus are muscular though not quite so thick as in *C. auriculatum;* therefore, since the character of the ventral papillae alone is not sufficiently important for a generic distinction, *C. auriculatum* must be retained in the genus Crepidostomum.

The distinction between *C. metoecus* and *C. cooperi* on the basis of position of ovary is questionable, although Braun's figures show the ovary posterior to the acetabulum. In his description he says only that the ovary is "hinter dem Bauchsaugnapf," which does not exclude the possibility that the ovary may overlap the ventral sucker in some specimens. *C. cooperi* agrees with Braun's brief description in every particular except the point discussed above, the proportions of the body and the suckers, and the fact that *C. cooperi* is smaller and contains more eggs.* According to Braun's measurements, the diameters of the

* Although Braun states that *C. metoecus* has five oral papillae, Odhner (1905) found six papillae in Braun's specimens. Braun found no esophagus in this species but said one might nevertheless be visible in living specimens.

suckers are one-tenth to one-eighth of the body length, and the width of the body is one-fifth to one-fourth of the length. In *C. cooperi* the diameters of the suckers are about a fifth of the body length and the width of the body is about a third of the length. While these proportions may be greatly changed by contraction or extension of the body, the difference in the relative size of the suckers, at least, seems great enough to be of diagnostic value. Probably further differences might be found in a detailed study of *C. metoecus*. Until such a study is made, it seems best to consider *C. cooperi* as a distinct species, since it differs from *C. metoecus* in the details discussed above as well as in host and in geographical distribution.

The genus Stephanophiala Nicoll (1909) has been shown by Odhner (1910) to be founded on differences which do not exist in reality or which are not of generic importance, and Nicoll (1924) has tacitly admitted that Stephanophiala is a synonym of Crepidostomum by using the name "*Crepidostomum farionis* [=*Stephanophiala laureata* (Zed.)]." The finding of more species has filled up many of the gaps formerly existing between *C. metoecus* and *C. laureatum*. As our knowledge stands at present Crepidostomum is a reasonably compact genus, containing no more than the usual diversity of forms. Faust (1918) accepted the generic name Stephanophiala and described the new species *S. vitelloba*. After a study of Faust's description and figures and of his type specimens, I am inclined to think that Faust's specimens are merely young individuals of *C. laureatum* which have just reached the egg-producing stage. A definite decision on this point cannot be given at present; in the meantime the name of Faust's species must become *Crepidostomum vitellobum* (Faust 1918).

Stafford's (1904) record of *Crepidostomum laureatum* from *Perca flavescens, Stizostedion vitreum,* and *Necturus maculatus* has several times been cited, together with Cooper's record, as evidence that C. *laureatum* parasitizes other hosts than the Salmonoidei. The discovery that Cooper's identification is erroneous causes one to doubt the validity of Stafford's record. As a matter of fact, Stafford listed his specimens as two "varieties which I feel almost forced to regard as species": one from *Perca flavescens* and *Stizostedion vitreum* "with large regular testes flattened against each other and a little obliquely placed," and the other from Necturus "still more slender with ventral sucker, ovary and testes moved farther forward in the body." These brief descriptions do not permit us to say what species Stafford's specimens were, but they do not suggest *C. laureatum,* and since Stafford himself did not consider these "varieties" as quite identical with the species from the trout, his record should not be cited as evidence that adult forms of *C. laureatum* inhabit other hosts than the Salmonoidei.

SUMMARY

1. Cooper's specimens reported in 1915 as *Crepidostomum laureatum* have been studied and are found not to be *C. laureatum.*

2. The specimens from *Perca flavescens* are found to represent a new species described in this paper as *Crepidostomum cooperi.*

3. The specimens from *Bolcosoma nigrum* are described as another new species, *C. canadense.*

4. The specimens from *Eupomotis gibbosus* are immature and cannot be identified as belonging to any known species.

5. Cooper's metacercariae from Hexagenia nymphs almost certainly do not belong to *C. laureatum;* it is suggested that they may be the metacercariae of *C. canadense.*

6. Specimens representing a new species of Crepidostomum from *Ambloplites rupestris* have been found in Cooper's collection and are described as *C. ambloplitis.*

7. A key to the papillose Allocreadiidae is given, and the status of some of the species is discussed.

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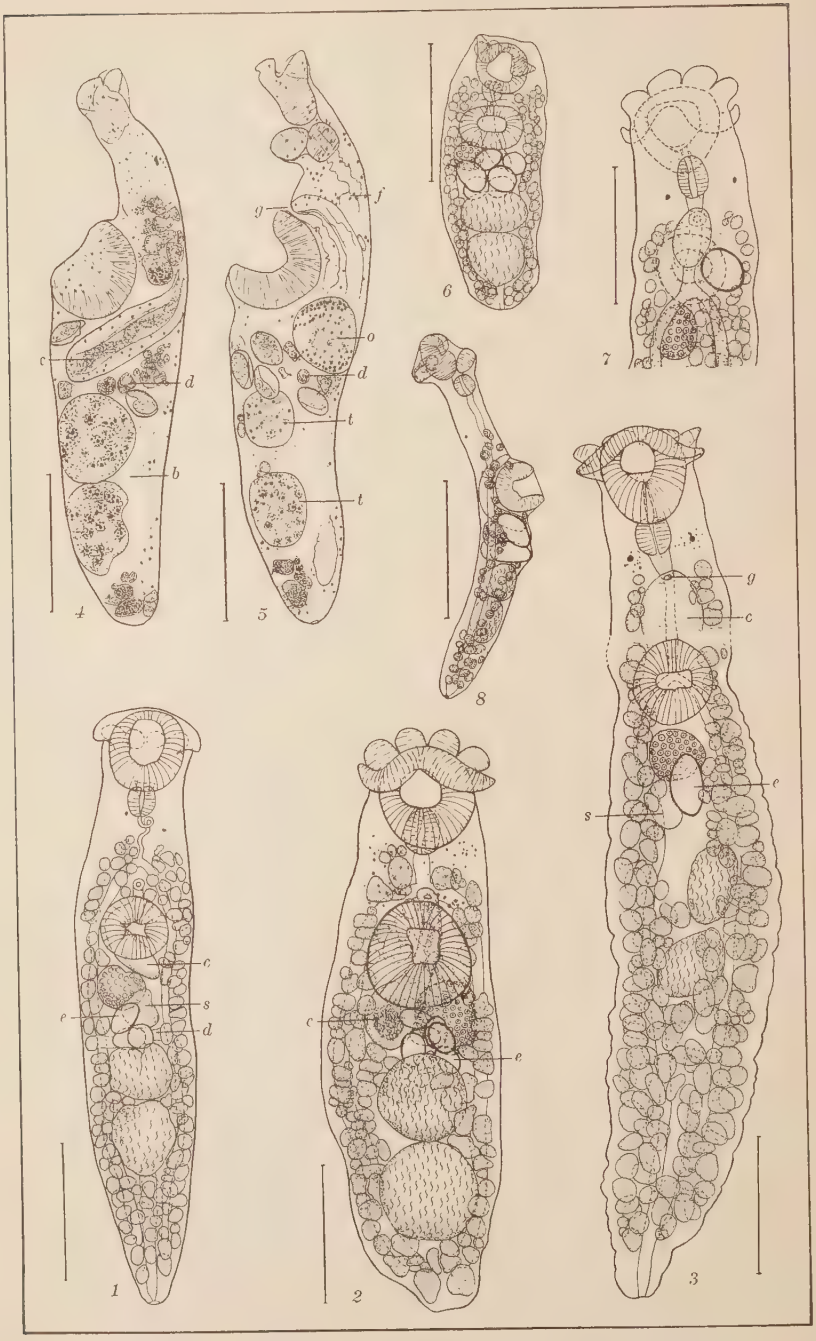


PLATE VII

Skworzoff, A. A. 1927.—Uber den anatomischen Bau des Saugwurmes des Sterlets des Wolga Flussystems—*Acrolichanus auriculatus* (Wedl 1856). Samml. Helminth. Arbeit. Prof. K. I. Skrjabin gewidm., Moskau, 1927:280-290; 10 figs.

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## Explanation of Plate VII

All drawings made with aid of camera lucida. Scale line represents 0.2 mm. in all figures.

### Abbreviations Used

*b,* excretory bladder; *c,* cirrus pouch; *d,* vitelline duct; *e,* egg; *f,* crural fork; *g,* genital pore; *o,* ovary; *s,* seminal receptacle; *t,* testis.

Fig. 1.—*Crepidostomum ambloplitis,* type specimen, whole mount, ventral view

Fig. 2.—*Crepidostomum cooperi,* type specimen, ventral view; drawn in oil of wintergreen under cover slip, after staining.

Fig. 3.—*Crepidostomum canadense,* type specimen, ventral view; drawn in oil of cedar under cover slip without staining.

Fig. 4.—*C. cooperi,* sagittal section through posterior end of cirrus pouch.

Fig. 5.—*C. cooperi,* sagittal section through pharynx, crural fork, and genital pore. This and preceding figure made by superimposing camera drawings of three consecutive 20μ sections.

Fig. 6.—*C. cooperi,* small mature specimen, whole mount, ventral view.

Fig. 7.—*C. canadense,* anterior end showing cirrus pouch; dorsal view, drawn under cover slip, in cedar oil, unstained.

Fig. 8.—*C. ambloplitis,* whole mount, lateral view.

# NOTES ON A SPECIES OF LERNAEA PARASITIC IN THE LARVAE OF *RANA CLAMITANS*

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From October, 1929, to March, 1930, and during the spring of 1931, first year tadpoles of *Rana clamitans* from a goldfish hatchery near Cincinnati, Ohio, were observed to be infected by a new species of Copepoda for which the name *Lernaea ranae* is proposed.

The genus Lernaea was erected by Linnaeus in 1758 to contain three species, two of which, *L. cyprinacea* and *L. salmonea,* are parasitic in fresh-water fishes, while the third, *L. asellina,* occurs in marine fish. *L. salmonea* and *L. asellina* have since been named types of the genera Salmonicola and Medesicaste respectively, leaving *L. cyprinacea* as type of the genus Lernaea. Excellent historical and critical reviews of the genus and of the family Lernaeidae as well as bibliographic references to earlier papers are contained in papers by Wilson (1917, 1918). Subsequently, the species *L. haplocephala,* described by Cunningham in 1914 from Lake Tanganyika and the Nile, was reported from the Congo basin by Wilson (1920a) and from the Cameroun by Brian (1927). Leigh-Sharpe (1925) described *L. elegans* from the buccal cavity of the Japanese eel, *Anguilla japonica.* The life history of this species was later studied by Nakai (1927) and a description of its internal anatomy and effects upon the host was published by Matsui and Kumada (1928). Wilson (1928) reported a new species, *L. composita,* from *Malapterurus electricus* from the Nile.

The first species reported from the United States was *L. cruciata,* described by Le Sueur in 1824 from Lake Erie. Krøyer in 1863 described *L. catostomi* and *L. pomotidis* from the Mississippi River. Kellicott in 1881 added *L. tortua* from New York and *L. pectoralis* from Michigan. Wilson (1916) described two species, *L. tenuis* and *L. variabilis* from Fairport, Iowa; he also reported the occurrence of *L. pomotidis* and *L. tortua* at Fairport, Iowa, and listed *L. cruciata* from Fairport, Iowa, Scott, Arkansas, and Black Creek, North Carolina. Two new species, *L. anomala* from North Carolina and *L. dolabrodes* from Wisconsin, were added by Wilson (1918). He later (1920) proposed the name *L. insolens* for *L. anomala,* preoccupied. In a brief preliminary paper, Enders and Rifenburgh (1928) reported an unnamed species of Lernaea parasitic in goldfish from Indiana. In addition to the species cited, several others have been recorded, particularly by early

investigators, but the descriptions in certain instances are not sufficient to identify them even as lernaeans.

Okada (1927) reported the occurrence of *L. cyprinacea* in *Diemyctylus pyrrhogaster* in Japan and stated that it was probably the same species that had been found in tadpoles of *Rana catesbiana* by Watase in the neighborhood of Tokio. It had previously been found in the goldfish, *Carassius auratus*. With the exception of the species described below, this appears to be the only instance in which copepods have been found in amphibian hosts.

*Learnaea ranae* n. sp.

The adult female is anchored in the tissues of the host by means of four processes which are outgrowths of the thorax. The unsegmented free portion of the thorax and the abdomen protrude posteriorly from the skin of the host through an opening slightly larger than the parasite. The point of attachment varies in position although it is located most frequently at the junction of the body and tail. In this region (Fig. 1) the parasites have been found in the zone extending from the edge of the fin to the base of the leg. In addition they have been observed posteriad in the heavy muscles of the tail, and in one instance the anchor processes were embedded in the wall of the hind gut. They were found twice in the hyoid apparatus and once with the body protruding from the operculum. In all cases the anterior end was embedded in a mass of connective tissue which seems to be formed by the host as a reaction to the presence of the parasite. When the copepod is dissected out, this tissue adheres to the group of anchor processes. The depth of penetration varies and it is difficult to remove the parasites without injuring them.

The incidence of infection is probably less than one percent. An accurate determination has not been possible because tadpoles were removed from the tanks in large numbers for other experiments and in some instances those found to be infected were replaced with the original lot, thereby apparently increasing the percentage of infection. Multiple infection is common. As many as six copepods have been found in a single tadpole, but more than three are seldom present in one individual. Infestation appears to be a matter of chance, and unless too heavy or localized in vital spots, it is probably not fatal to the host. Many tadpoles have been found with one or more holes in the skin, which apparently remained after the death of the copepods. Occasionally there are external signs of inflammation in the parasitized regions, with rare cases of bleeding through the orifice in the skin.

The body regions of the adult female are shown in Figure 2. A representative specimen measures 7.3 mm. in total length (without egg sacs). The cephalon or head is 0.21 mm. long, 0.27 mm. wide, and

turned ventrally. It is distinctly separated from the thorax dorsally, but there is no demarcation on the ventral side. The cephalon is provided with two pairs of antennae, an anterior pair measuring 0.17 mm. and a posterior pair 0.13 mm. in length. The detailed structure of the mouth parts has not been determined. The mandibles, maxillae and maxillipeds have been observed in sections but their relations were difficult to determine. In specimens just dissected from the host, masticatory movements have been observed.

The thorax may be divided arbitrarily into two regions, an anterior one bearing the anchor processes and a posterior free portion which extends outside the host. The free portion represents the region which undergoes elongation after the parasite becomes attached to the final host. In the specimen described above, the thorax is 0.3 mm. wide at the neck region and 0.58 mm. wide at the pregenital prominence. There are four anchor processes, a ventral uniramous and a dorsal biramous pair. These organs are semi-rigid and are firmly embedded in the host tissue. In the specimen whose measurements are given, the processes are somewhat longer than in the one shown in figure 2. The ventral processes, from the center of the thorax to the tips, measure about 1.16 mm.; the stems of the dorsal pair are 0.66 mm. long, with anterior rami measuring 1.29 mm. and posterior rami 0.79 mm. in length. In this specimen the dorsal processes were distinctly anchor shaped, as a result of the slight curvature of the rami. Although possessing a fundamental form, the processes vary to a considerable extent in orientation and in size of the rami which in some specimens are merely small knob-like protuberances.

The first two pairs of swimming legs are between the ventral anchor processes and are difficult to locate. The third and fourth pairs of swimming legs (Figs. 2, 5, 6) are distinctly visible on the ventral side of the free portion of the thorax. The fifth pair are located at the posterolateral edges of the pregenital prominence and are apt to be overlooked on account of their small size.

The short abdomen lies posterior to the pregenital prominence and in the same axis as the thorax. Little if any torsion has been observed in the body. Thick red or black deposits, which can be readily scraped off with a sharp scalpel, are often found on the free portion of the body.

The mouth is followed by a short esophagus which leads into an expanded stomach. In sections the wall of the stomach shows convolutions. The intestine, uniform in diameter throughout the thorax except for a slight enlargement in the region of the pregenital prominence, narrows abruptly a short distance in front of the anus and communicates with the short rectum. The entire digestive tract is greenish in color and moves in a rythmic peristaltic manner.

The typical position and shape of the oviducts are shown in Fig. 2, although changes may accompany formation of the egg sacs which appear in late winter and early spring. The latter structures (Fig. 4) are attached to the postero-ventral edge of the pregenital prominence. Their length is not more than one-fourth that of the body, usually much less. The number of eggs in a sac varies from eight to thirty or more, and consequently the size of the sacs varies considerably. The eggs are irregularly multiseriate and are not compressed.

## DEVELOPMENT

Since the hosts are so active, it is desirable to remove the eggs in order to observe their hatching. This can be done by passing a sharp scalpel forward close to the abdomen of the parasite, cutting the stalk-like attachment of the sac, or by pulling out the body with the sacs attached. When placed in Syracuse watch dishes with spring water, the eggs hatch into typical nauplius larvae (Fig. 3). Such larvae were obtained in the laboratory on March 15, and April 1, 1931. When disturbed, they swim about with jerky movements, finally coming to rest on the bottom of the dish, usually with the ventral side up. Except for the greenish visceral mass and the red eye, the entire body is transparent under moderately strong illumination. The eye is about 8.5$\mu$ wide and when viewed with a darkened field, is of a brilliant red color. The body of a typical specimen measures 0.17 mm. long and 0.119 mm. wide; the first pair of appendages are 56$\mu$ long and 17$\mu$ wide at the basal segment; the second pair are 85$\mu$ long and 25$\mu$ wide at the base; the third pair are 59$\mu$ long and 20$\mu$ wide at the base. The structure and position of the appendages are shown in figures 3, 7, 8 and 9. The posterior end of the body bears two spines.

The process of molting requires about thirty minutes after the first appearance of the loosened cast at the posterior end of the body. A number of nauplii were kept in a single dish and for this reason it was impossible to follow any particular individual through successive molts. Several of them were observed to molt and after the process they did not have the appearance of metanauplii. An examination of the casts indicated that there may be two molts before the metanauplius stage is reached. This stage is characterized by several changes. The visceral mass becomes smaller, while the body becomes slightly elongated. The position and structure of the appendages are altered and additional spines appear at the posterior end of the body, which loses its somewhat pointed appearance as slight depressions develop on each side. The larvae reach the metanauplius stage within forty-eight hours after hatching. All of them died before reaching the copepodid stage.

## DISCUSSION

*Lernaea ranae* occurs in tadpoles which were taken from a goldfish hatchery. Since goldfish were originally imported from the Orient, and since Okada has reported a form which he identified as *L. cyprinacea* in newts, tadpoles, and goldfish in Japan, it appears possible that the present species might be identical with the one reported by him. There are strong reasons, however, for believing that the species here described is not identical with *L. cyprinacea.* The anchor processes of the present specimens are similar in form to those described by Okada but he reported that the abdomen is inclined at an angle to the thorax and that the egg sacs are two-thirds as long as the body, whereas in *L. ranae* the abdomen invariably lies in the same plane as the thorax and the egg sacs are never more than one-fourth the length of the body. Furthermore, Wilson (1918) stated that *L. cyprinacea* is 22.5 mm. in length, or three times as long as *L. ranae,* and the anchor processes of *L. cyprinacea* as figured by Wilson differ distinctly from those of *L. ranae.* With respect to the abdomen, *L. ranae* resembles *L. composita* but the anchor processes of the two species differ greatly, those of *L. composita* being thick and unbranched. None of the other described species are as similar to *L. ranae* as those mentioned above. There is a possibility that the unidentified species found in goldfish by Enders and Rifenburgh (1928) is identical with *L. ranae,* but since their preliminary report included no figures, the question cannot be decided.

## SUMMARY

Tadpoles of *Rana clamitans* from a goldfish hatchery near Cincinnati, Ohio, were found to be infested with a new copepod for which the name *Lernaea ranae* n.sp. is proposed. The adult female is about 7 mm. long and has four anchor processes, a ventral uniramous and a dorsal biramous pair. The pregenital prominence is distinct and the abdomen lies in the same axis as the thorax. The eggs are multiseriate in arrangement and the sacs are less than one-fourth as long as the body. Eggs hatched in the laboratory on March 15 and April 1, 1931. The metanauplius stage is reached within 48 hours after hatching. All of the larvae died before reaching the copepodid stage.

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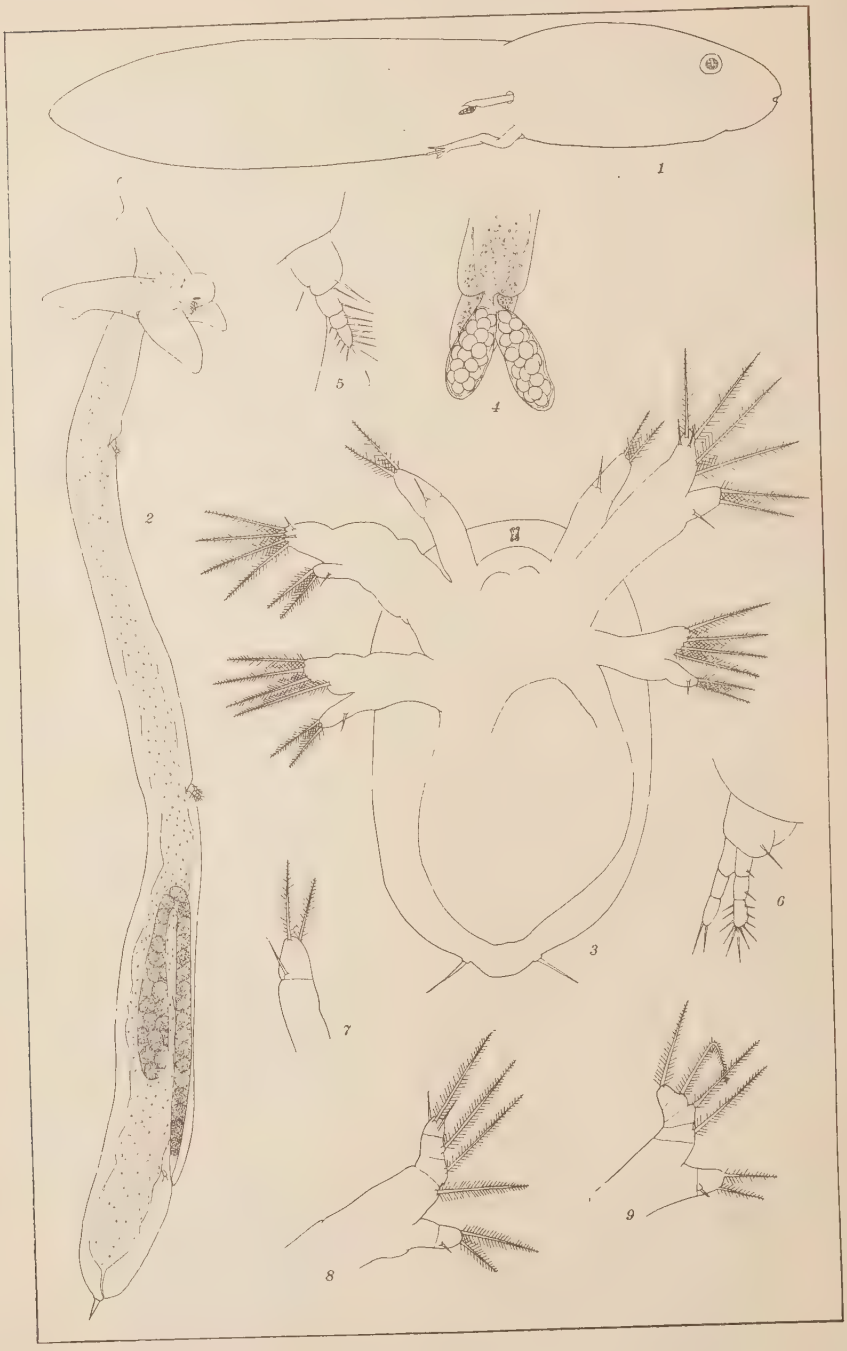


PLATE VIII

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## Explanation of Plate VIII

Fig. 1.—Tadpole, showing most frequent location of the parasite.
Fig. 2.—Adult female copepod (side view).
Fig. 3.—The nauplius (ventral view).
Fig. 4.—Posterior end of body showing the egg sacs.
Fig. 5.—Third swimming leg of adult.
Fig. 6.—Fourth swimming leg of adult.
Fig. 7.—First appendage of the nauplius.
Fig. 8.—Second appendage of the nauplius.
Fig. 9.—Third appendage of the nauplius.

# SOME PARASITES OF OKLAHOMA TURTLES

P. D. Harwood

During the summer of 1930, Mr. T. S. Chapman, Jr., sent me a number of turtles from Lake Taliwanda, McAlester, Oklahoma. The two species represented were *Pseudemys elegans* and *Pseudemys hieroglyphica*. Since the turtles had been kept in captivity with a very limited supply of food for some little time before Mr. Chapman obtained them for shipment, their intestines were practically empty, and doubtlessly many parasites had been lost. Nevertheless examination of twelve turtles yielded nine species of parasites, one of them new to science; three of them new host records; and one markedly extends the known geographic range of the species. Following is an annotated list of the parasites found, together with a description of the new species.

This work has been carried out under the direction and criticism of Dr. Asa C. Chandler, and to him I wish to express my sincere appreciation.

## TREMATODA

### *Polystoma orbiculare* Stunkard 1916

Several specimens were obtained from the urinary bladder of both species of turtles. It has previously been reported from *Chrysemys marginata* and *Pseudemys scripta* by Stunkard.

### *Polystoma megacotyle* Stunkard 1916

Three examples of this species were obtained from three specimens of *Pseudemys elegans*. This species was originally described from a very limited number of specimens taken from the mouth of *Chrysemys marginata*.

### *Polystoma stunkardi* new species

About 50% of the specimens of *Pseudemys hieroglyphica* examined were found to be infested with a polystome which closely resembles *P. multifalx* Stunkard, but differences were found which seem to justify the erection of a new species. The body is an elongate oval that measures from 3.6 to 5 mm. in length and from 1.2 to 1.8 mm. in width. The caudal disk is cordiform and of about the same width as the body. The suckers with the exception of the anterior pair lie very close together, but the anterior pair is separated by a distance greater than the width of a sucker. Between the caudal pair of suckers there is a pair of great hooks from 125 to 140$\mu$ long. Between these hooks there is a pair of intermediate hooks from 24 to 80$\mu$ in length. Apparently

the usual number of larval hooks are present on the disk in young worms, but any or all of them may be lost in mature individuals. They are about 20$\mu$ long.

The oral sucker and the pharynx are large and broader than long. The former measures from 0.36 to 0.5 mm. long and from 0.55 to


Text Fig.—*Polystoma stunkardi,* toto.

0.75 mm. wide; the latter from 0.36 to 0.55 mm. long and from 0.5 to 0.75 mm. wide. There is no prepharynx and the very short esophagus cannot be seen in whole mounts. It is 0.18 mm. long in a sectioned specimen and runs ventrad from the pharynx. The intestinal ceca extend just to the anterior margin of the caudal disk. They are lobed but not branched as in some exotic species of Polystoma. The intestinal

ceca give a crossbar effect at the anterior end as Stunkard (1924) mentioned for *P. multifalx*.

The single testis is median and slightly anterior to the middle of the body. It is nearly circular in outline and the diameter varies from 0.3 to 0.41 mm. The vas deferens passes cephalad, median to the ovary and dorsal to the ootype. The anterior end is enlarged to form a seminal vesicle 0.22 mm. long. The cirrus sac is circular or slightly oval, its diameter varies from 0.25 to 0.38 mm. The genital coronet is very similar to that of *P. multifalx* but it contains fewer hooks. In my eight specimens the number of hooks in the genital coronet varies from 92 to 109. Stunkard found 120 and 124 in his two specimens of *P. multifalx*. In a sectioned specimen the cirrus hooks are 80$\mu$ long.

The ovary is spherical and is situated above and on the left side of the body. It measured from 75 to 115$\mu$ in diameter. The oviduct leaves the posterior border of the ovary and turns at once ventrad and mediad toward the ootype. This organ receives the two vitellovaginal canals and gives rise to the genito-intesinal canal, which proceeds to the cecum on the side of the ovary. Mehlis' gland is represented by a few nuclei around the ootype. The vaginae open at the ventrolateral margins of the body, at the level of the ovary. The vitelline follicles posterior to the testis occupy the entire dorsal portion of the worm and even impinge slightly on the genital field. Cephalad they reach the caudal border of the pharynx and behind the pharynx a narrow band connects the two lateral fields. No specific characters were observed in the excretory system.

Type host: *Pseudemys hieroglyphica*

Habitat: Mouth

Type locality: McAlester, Oklahoma

Type specimen to be deposited in the U. S. National Museum.

This parasite closely resembles *P. multifalx* from the Florida terrapin. The important differences are the fewer hooks in the genital coronet, the smaller size of the cirrus sac and testis, and the arrangement of suckers on the caudal disk.

### *Allassostoma magnum* Stunkard 1916

Stunkard has published a full account of this species and reported it from two hosts, *Pseudemys troostii* and *P. elegans*. I have taken it from one specimen of the latter host.

### *Spirorchis innominata* Ward 1921

Two out of eight specimens of *Pseudemys hieroglyphica* were found to be infected with this blood parasite, and many of the turtles in which no worms were found had numerous eggs in the intestinal walls. From

one turtle 21 flukes were removed, which shows that the infection may at times be rather heavy. Stunkard (1923) reports this species from *Clemmys insculpta.*

*Spirorchis elegans* Stunkard 1923

Stunkard (1923) has described this species from two specimens taken from *Pesudemys elegans,* at Havana, Illinois. I have taken a single specimen from the heart of the same host.

NEMATODA

*Falcaustra procera* (Canavan 1929)

Canavan has described this species under the genus Spironoura Leidy. He apparently considered Falcaustra and Spironoura to be synonyms, but Walton (1927) has produced evidence to show that the two genera are not synonymous. Canavan reported that his material was obtained from *Pseudemys rubriventris.* About half the specimens of both *Pseudemys elegans* and *Pseudemys hieroglyphica* examined were lightly infested with this nematode.

*Camallanus trispinosus* (Leidy 1856)

Most of the turtles of both species were infected with this common parasite.

*Spiroxys contorta* (Rudolphi 1819)

A single specimen, which is referred to this species, was taken from the stomach of *Pseudemys hieroglyphica.*

*Neoechinorhynchus emydis* (Leidy 1851)

This common parasite of turtles was found in the majority of the turtles examined, and often in great numbers.

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# MYIASIS IN JACK RABBITS, *LEPUS CALIFORNICUS TEXIANUS*

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Larvae of the rabbit bot Cuterebra are found in the back of the jack rabbit at Uvalde, Texas, during two seasons of the year. The maturing grubs are more frequently observed from January through March but in June and early July the mature grubs are again found. As the latter season is one of blowfly activity, rabbits are subject to attacks from various blowflies at this time. All of the cases reported herein occurred in the hare *Lepus californicus texianus* Waterhouse, commonly known as the Texas jack rabbit.

During June, 1930, three cases were observed in which blowfly infestations followed those of Cuterebra. Case A was found on June 20, cases B and C on June 21. In each instance the rabbit was killed in its natural habitat, viz., open brush country with vegetation consisting mostly of mesquite. The blowfly larvae were mature at the time the rabbits were killed, therefore oviposition probably occurred about June 17 or 18. The temperatures from June 17 to June 21 were as follows: maximum 93°F., minimum 68°F., average mean 81°F. On June 15 a rainfall of 6.08 inches was recorded; hence the humidity at the time of oviposition was probably above normal.

In studying these cases technique was employed which prevented contamination of material by subsequent oviposition or larviposition of flies. All collections from the wounds were put in pint mason jars containing sifted sand, and the jars were capped with lids of 60-mesh brass strainer cloth. These jars were then placed in fly-proof, glass-topped breeding cages, and the cages put in a fly-proof insectary. The larvae pupated in the sand within the jars and were not disturbed until emergence occurred.

The writer is indebted to Dr. J. M. Aldrich of the U. S. National Museum for determination of the specimens of Cochliomyia, and to Mr. David G. Hall for identification of the Sarcophaga.

### *Record of Blowfly Attack Following Cuterebra Infestation*

Case A. On June 20, a large female rabbit was killed which had a wound 25 mm. in diameter located on the rump just above and to the right of the tail. The blowfly larvae had penetrated the flesh to a depth of 19 mm. The initial injury was quite clearly caused by a Cuterebra larva which had left the cyst before the rabbit was examined. The lesion was

not discharging and there was little swelling or necrosis of the adjoining flesh. Twenty-four matured fly larvae were removed and from these 20 adults of *Cochliomyia macellaria* Fab. emerged on June 30.

Case B. On June 21 an adult rabbit was killed approximately five miles from where Case A was found. The initial wound was evidently caused by a Cuterebra larva which had migrated. The lesion was located on the rump at the right of the base of the tail. It extended through the abdominal wall and the larvae had penetrated the hind gut. The wound was 30 mm. long by 20 mm. wide. About fifty larvae were removed and from these 35 adults of *Cochliomyia macellaria* emerged on June 30.

Case C. A large jack rabbit was killed in the same locality as Case B, on June 21. The wound on this rabbit was 50 mm. long, 30 mm. wide on the right side, and narrowed to 20 mm. on the opposite side. The main portion of the wound was on the rump at the right of the tail but part of it extended to the left of the tail. It extended into both hams but the hind gut was not penetrated. Three Cuterebra larvae were present; two of these were dead, but the third was mature and active. From this case 138 fly larvae were removed. The following are the emergence records of adult flies from this lot: June 30, 81 *Cochliomyia macellaria* Fab. July 3, 5 more of the same; July 16, 2 *Sarcophaga sulcata* Ald. and July 20, 1 more of the same.

### *Myiasis Following Gunshot Wounds*

In addition to the above cases of myiasis, two other records of blowfly attacks on rabbits were recorded. In these two instances the infestations followed gunshot wounds.

Case D. A large rabbit was killed on July 31 in dense mesquite brush. A gunshot wound was present in the fleshy part of the right hind leg at the juncture of the femur and tibia. There were two openings to the wound, one 30 mm. in diameter, immediately anterior to a smaller one 15 mm. in diameter. Only the larger of the two wounds was infested with fly larvae. From the edge of this wound was removed a mass of fifty eggs of *Cochliomyia macellaria*. The wound penetrated 55 mm. and enlarged to twice its external diameter. There was a seropurulent discharge and foul odor. The hair was falling from adjoining areas of skin. From the larvae removed 4 *Cochliomyia macellaria* emerged on August 11, and during the period of August 19 to 26, 35 *Sarcophaga plinthopyga* Wd. emerged.

Case E. On August 29, an adult male rabbit was killed in dense mesquite brush. The rabbit had been shot previously with a small-caliber rifle. The bullet had entered at a point just below the junction of the right foreleg and the body, proceeded through the fleshy part,

grazed the ribs, and passed out at the rear of the right shoulder. The opening through the skin was slightly oval and about 40 mm. in diameter. There was a dark-colored watery discharge and an extremely offensive odor. The infestation was barely visible from the outside, but when the wound was cut into the larvae were found to have destroyed the flesh nearly to the shoulder bone and to have burrowed between the skin and the flesh for 25 mm. in all directions. The channel made by the bullet was completely filled with small maggots. All larvae that could be reached were collected, but some few escaped. From the material collected 20 *Cochliomyia macellaria* emerged on September 11 and 12 and 38 *Sarcophaga plinthopyga* emerged between September 14 and September 23.

### *Discussion of Species of Flies Reared*

Sixty-eight per cent of the flies bred from the rabbit wounds were the common screw-worm fly of the Southwest, *Cochliomyia macellaria*. This species is responsible for most cases of myiasis in this locality. This fly was bred from each case recorded above. Bishopp (1915) discusses fully the relation of *C. macellaria* to myiasis.

In only one instance were specimens of *Sarcophaga sulcata* Ald. (*sulculata* Ald.) obtained. This species is described by Aldrich (1916) and is known to be a carcass breeder in this region of the United States.

*Sarcophaga plinthopyga,* also a carcass breeder, is the most common Sarcophaga at Uvalde, Texas. It was not bred from the Cuterebra wounds but it followed *C. macellaria* in both instances of gunshot wounds. In these two cases the wounds were extremely foul, a condition most likely to attract *S. plinthopyga.* Patton and Evans (1929) list *S. plinthopyga* as a species which may be found in gunshot wounds in man.

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# A NEW SPECIES OF HAPLONEMA WARD AND MAGATH 1916 FROM THE STOMACH OF *LOTA MACULOSA* *

J. M. Moulton

A collection of twenty-three nematodes, nineteen females and four males was taken from the stomach of a ling caught in Lake Simcoe, Ontario, Canada. The anterior end was characteristically curved dorsally like a shepherd's crook. In addition the posterior end of the male was tightly curled into as many as three spirals; that of the female was practically straight. Their morphology in general is found to agree with the well known structures of the genus Haplonema Ward and Magath 1916. The only species included in this genus is *H. immutatum* described at the same time the genus was created. The description of that species, however, differs considerably from these specimens; consequently the author offers the name *Haplonema hamulatum* for the new form.

The following comparison will serve to distinguish the two species. In size both sexes of *H. hamulatum* are distinctly smaller than *H. immutatum,* the extreme length of the males being 8.7 mm. and the average length only 7.7 mm. while the males of *H. immutatum* are about 9.5 mm. and the average width is 0.13 mm. as compared with 0.2 mm. of the old species. The females average 9.04 mm. in length by 0.16 mm. in width in comparison with the length of 15 mm. and width of 0.31 mm. in *Haplonema immutatum.* The anterior ends are quite similar in both forms, but the lateral alae extend posteriorly not more than 1.0 mm. instead of from 2.5 to 3.0 mm. as in *H. immutatum.* Although the old species is considerably larger in most respects the muscular esophagus is comparatively smaller than in these specimens measuring in the former 0.65 mm. in the male and 0.8 mm. in the female by 0.06 mm. anteriorly and 0.1 mm. near its posterior end; in the other it measures 0.50 mm. in both males and females by 0.02 mm. in the narrowest region anteriorly to 0.06 mm. posteriorly. There is an indistinct partition near the middle of the esophagus which divides it into two regions histologically similar and the posterior enlargement is not to be considered a bulb. The intestine extends undifferentiated from the end of the esophagus to the small spherical sphincter muscle which separates it from the proctodeum about 0.54 mm. from the posterior end.

* Contribution from the Zoological Laboratory of the University of Illinois, under the direction of Henry B. Ward, No. 411.

The vulva in the female specimens is somewhat posterior to that in *H. immutatum* and is connected by a thick walled vagina from 0.20 to 0.23 mm. long and from 25 to 50$\mu$ wide, which extends anteriorly, to the two uteri which extend straight anteriorly and posteriorly from the point of attachment. The two ovaries are long bands of single cells in line, the divisions between the cells giving the ovaries the appearance of being segmented. This cellular nature is not apparent at the distal end of the ovaries. The cells become increasingly large as the ovary nears the point of attachment to the oviduct. Here the cells may be 75$\mu$ wide by 25$\mu$ or more long. One ovary originates from 1.5 mm. to 2.0 mm. from the anterior end, coils transversely posteriad for a short distance then extends straight to the point where it joins the oviduct about 1.5 mm. from the posterior end. The oviduct, about 35$\mu$ wide, continues posteriorly about 0.22 mm. then bends sharply upon itself and extends approximately 1.12 mm. to join the uterus. The other ovary starts about 0.54 mm. from the posterior end, coils transversely forward for a short distance then extends straight to within 3.0 mm. of the anterior end where it joins its oviduct, which continues anteriorly a short distance then bends sharply posteriad to join the uterus. The eggs are not very numerous, not more than four occurring at any one point and only one near the vulva. They are ovate or spherical in shape varying from 35 to 55$\mu$ in length, the width (35$\mu$) being fairly constant. Those of *H. immutatum* are considerably larger measuring 65 by 45$\mu$ and are smooth shelled while the shells of this form are regularly marked with minute pox.

In the male of *H. hamulatum* the two approximately equal spicules are much smaller, only 0.12 mm. in length by 7$\mu$ in width while those of *H. immutatum* are 0.75 long by 0.02 mm. wide. In one of these males there is a very evident chitinous fan shaped accessory piece protruding just anterior to the cloaca. It is 50$\mu$ broad by 47$\mu$ high and the fan part gives the appearance of being paired. In the other three specimens this structure cannot be distinguished with certainty. The single testis originates near the posterior end of the intestine as a chord composed of many small cells extending straight anteriad to within 0.64 mm. of the anterior end where it bends upon itself sharply posteriad. About 0.24 mm. from the bend begins the thin walled vas deferens, 0.11 mm. wide filled with numerous amoeboid cells. About 0.15 mm. from its beginning the walls of this tube thicken and numerous dark staining bodies mixed with the amoeboid cells seem to mark the beginning of the seminal vesicle. It is reduced to half size about 0.17 mm. further on and then widens to join the ejaculatory duct, a thick walled muscular tube about 40$\mu$ wide with a lumen only 5$\mu$ wide. This joins the digestive tube at or just posterior to the sphincter muscle.

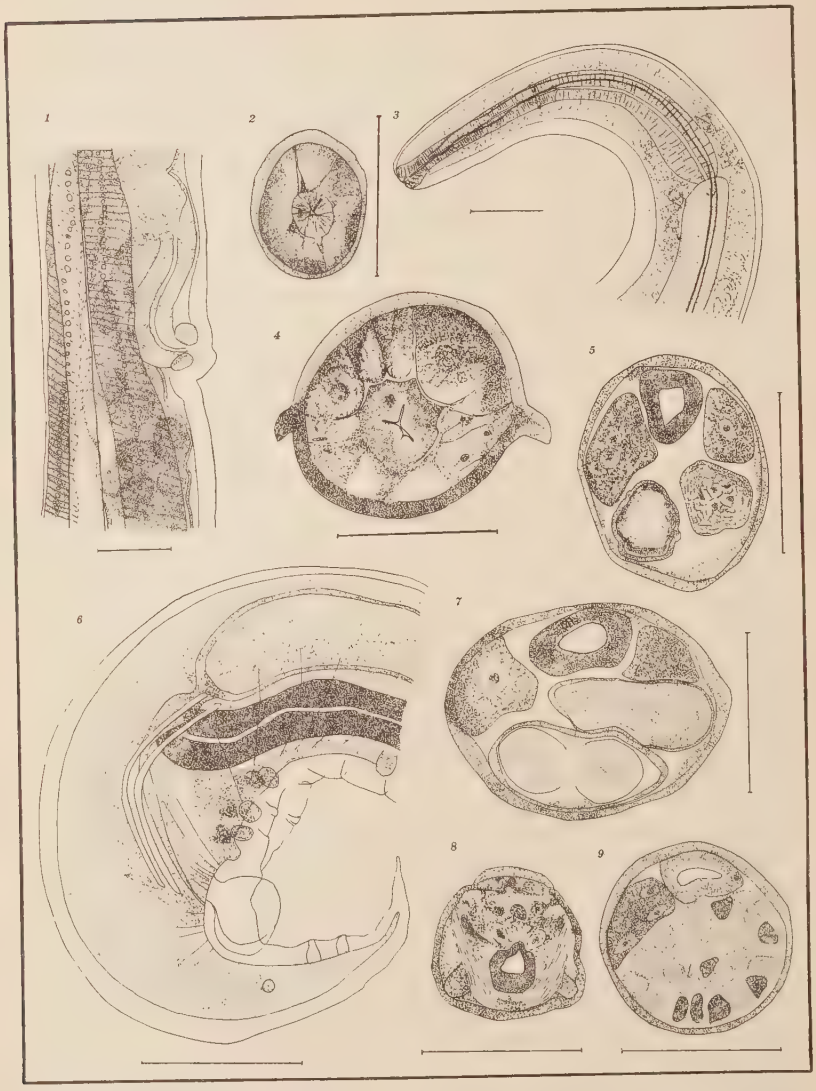


PLATE IX

The body musculature is well developed only in the anterior portion and is meromyarian. In the posterior end of the males, giving them the appearance of being striated, is a secondary development of musculature beginning about 2 mm. from the end. It is composed of two bundles of long narrow fibers extending dorso-laterally from a point in the midventral line to a point well above the midlateral line. The cells appear quite different from those of the musculature of the anterior end and the protoplasmic body of each cell is indistinguishable whereas in the anterior end the protoplasmic portion is quite distinct and large nuclei are apparent in cross section.

## Explanation of Plate IX

Scale of figures 1 and 3 is 0.1 mm., other figures is 0.2 mm.

Fig. 1.—Lateral view in region of the vulva showing intestine, two ovaries, uterus, vagina and vulva.

Fig. 2.—Cross-section of anterior end anterior to the beginning of the lateral alae, showing the esophagus and body layers.

Fig. 3.—Lateral view of head showing lateral alae, nerve ring, esophagus divided into two regions by a partition just posterior to nerve ring, esophageal valve, and anterior end of intestine.

Fig. 4.—Cross-section in region of anterior end of intestine showing character of intestine, musculature, and lateral alae.

Fig. 5.—Cross-section just anterior to vulva showing intestine, two ovaries, uterus and vagina.

Fig. 6.—Lateral view of tail of male showing posterior end of intestine, ejaculatory duct, cloaca, spicules, accessory pieces and pre- and post-anal papillae.

Fig. 7.—Cross-section just posterior to vulva showing intestine, two ovaries and uterus with two eggs.

Fig. 8.—Cross-section through the tail of the male showing the musculature, the spicules, the cloaca and the papillae.

Fig. 9.—Cross-section through posterior fourth of male showing intestine, testis, and seminal vesicle with masses of developing sperm cells.

# EIGHT CASES OF HUMAN INFESTATION WITH THE RAT TAPEWORM *(HYMENOLEPIS DIMINUTA)* *

A. E. Keller

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During the past two years a study of the common human intestinal parasites in Tennessee has been made, comprising over 31,000 examinations from all parts of the State. Most of the examinations were made on children between the ages of five and nineteen years. During this investigation eight cases of *Hymenolepis diminuta* were found, and it was thought worthwhile to report this group because of the fact that this parasite has been considered very rare in man. Riley and Shannon (1922) after carefully reviewing the literature reported a total of sixty-one cases. Butka (1924) reported one case. Gundrum and Snyder (1927), Momma (1928), and Spindler (1928) each reported one case. Chandler (1927) in a study of hookworm and other helminths in India found twenty-three cases of *Hymenolepis diminuta* in approximately 10,000 fecal examinations. He also reported several other cases of infestations with this parasite among hospital patients in Calcutta. Clark (1930) reported another case. Information has been obtained from Mr. T. F. Sellers, Director of Laboratories of the State of Georgia, that during the past thirteen years eleven cases of *Hymenolepis diminuta* have been found in that laboratory. Up to the present time, therefore, reports of about one hundred cases of this parasite are available.

The cases reported at this time were found in middle and east Tennessee, the eight cases being distributed in six counties. The following table shows the age, sex, and color of seven of the cases in this group. The eighth case, for which this information is not available, was found in Union County in September, 1929, by Doctor G. F. Otto, who has kindly consented to its inclusion in this report.

It was possible to obtain a clinical history in only one case, that of an eight year old white boy. The boy was treated and eggs of *Hymenolepis diminuta* were obtained from the segments which were recovered following treatment. The boy had handled rats frequently, especially when they were trapped or were shot by some member of his

* From the Department of Preventive Medicine and Public Health, School of Medicine, Vanderbilt University, and the Tennessee State Department of Public Health.

family. Rats were very prevalent on the premises, and from the information obtained the child had a rather peculiar liking for the examination of rats. No other cases could be found by examining the feces of other members of this family. In another family, however, two cases were found in sisters, aged eleven and twelve years.

According to Chandler (1930) *Hymenolepis diminuta* is very common in rats and mice in all parts of the world. The worm requires an intermediate host for development of its cysticercoid larva. The intermediate hosts include grain infesting insects, larvae and adults of meal moths (*Pyralis farinalis*), nymphs and adults of ear-wigs (*Anisolabis annulipes*), adults of various grain beetles, such as Tenebrio, Akes and Scaurus, dung beetles (Geotrupes) and cockroaches, as well as the larvae of fleas and myriapods. Joyeux (1920) considered the grain beetle, *Tenebrio molitor,* and rat fleas to be the usual intermediate hosts. When

| Case Number | | Age | Sex | Color |
|---|---|---|---|---|
| 1 | ..... | 12 | F | White |
| 2 | ..... | 11 | F | White |
| 3 | ..... | 4 | M | White |
| 4 | ..... | 7 | M | White |
| 5 | ..... | 8 | M | White |
| 6 | ..... | 7 | F | Negro |
| 7 | ..... | 12 | M | White |
| 8 | Report from Union County, Tennessee, by Doctor G. F. Otto | | | |

these insects are eaten, the cysticercoids are liberated and the adult worms develop. Chandler also stated that human infestation results from eating such foods as dried fruits and precooked breakfast cereals in which the grain insects are present.

The cases reported in foreign countries have been distributed geographically as follows: Brazil, India, Italy, Nicaragua, Argentina, Belgium, Cuba, East Africa, Japan, Philippine Islands, Martinique in the French West Indies, and Grenada in the British West Indies. In this country, cases have been reported from the following states Arkansas, California, District of Columbia, Georgia, Indiana, Minnesota, Nebraska, North Carolina, and Tennessee. The increasing number of reported human cases infested with this parasite is probably due to the extensive fecal surveys which have been made recently and to more general recognition of the egg. It is hardly reasonable to suppose that the incidence of the worm in man is increasing, since there is a tendency toward a decrease in both the rodent and insect hosts, and man is learning to guard himself against contamination of his food by these hosts.

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# A SIMPLE METHOD FOR COLLECTING ADULT FILARIAL PARASITES FROM MUSCLE TISSUES OF MONKEYS

LAWRENCE H. DUNN

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Filariasis is an important monkey disease in Panama (Clark, 1931). It is present in practically every adult monkey caught in the jungle yet the marmosets (*Saimirí örstedii örstedii* and *Leontocebus geoffroyi*) as well as the night monkey (*Aotus zonalis* Goldman) fail at autopsy examinations to show the adult parasites in any of the serous cavities as is commonly the case with other local species of monkeys. Faust (1930) learned recently that the adult parasites were located in the muscles of the back of the squirrel monkey, *Leontocebus geoffroyi* (Pucheran). This is a titi or marmoset monkey found in great numbers in Panama. Although the adult filarial parasites may be present in great numbers in the musculature of these small monkeys, it is a time consuming task to find and remove them without injury to the parasites.

One of these squirrel monkeys (Lab. No. 59) had been kept under observation at this laboratory for several months and during this period abundant microfilaria were found in its blood films at each examination. This animal died of another disease and a careful autopsy examination revealed no adult filarial parasites in the cavities. Following the advice of Faust the musculature was shredded and a number of these worms were found in the back and thighs but it was impossible to remove them without breaking them into many fragments. They measured from 85 to 90 mm. in length and were very slender and so thoroughly embedded in the muscle tissue that when one was grasped with forceps and an attempt made to pull it out fragmentation of the parasite resulted. Only one unbroken specimen was secured from this animal and it was obtained after considerable time had been spent extracting it.

A second monkey of the same species (Lab. No. 42) that had shown abundant microfilaria in its blood films for a long time was found in a dying condition, the result of a spirochetosis. The laboratory wanted to examine the musculature of this animal immediately after death in order to obtain as many adult filarial parasites as possible from the fresh tissues. It was chloroformed and the following method employed to secure unharmed parasites. The skin was removed from the monkey immediately after its death. The feet were cut off and the viscera removed from the thorax and abdomen. The body was left to cool for a few minutes and then the blunt handle of a scalpel was employed to

tear the muscle groups apart in the back and extremities. The carcass was then placed in a glass dish containing about two liters of approximately normal salt solution heated to a temperature of a little more than 99°F. Very soon after the carcass was placed in this solution the filaria began to emerge from the tissues and twenty minutes later a number of them were protruding until nearly their full lengths were moving about in the liquid. By grasping them lightly with forceps only very gentle traction was necessary to separate them entirely from the muscles so that they could be removed from the salt solution and transferred to a fixing fluid. The dish containing the carcass was now placed in an incubator to raise the temperature of the fluid to slightly more than 99°F. This second heating seemed to hasten the emergence of some of the worms that were slow in leaving the tissues. The dish was removed from the incubator at the end of thirty minutes and several more of the thread like worms were found floating about in the fluid but still lightly attached to the carcass. A total of nineteen specimens of adult filaria were obtained from this animal. Six of these consisted of three pairs that emereged from the tissues while in copulation and they remained in this state until killed by the fixing fluid. Pairs of these parasites in copulation could hardy have been secured by simply pulling them from the tissues with forceps. The method has been further simplified recently. The dish of saline solution is now placed in the incubator as soon as the carcass has been immersed and allowed to remain there at a temperature of 99°F. from two to four hours. This causes some of the filaria to leave the carcass entirely and they may be found moving about in the fluid or coiled on the bottom of the dish. It is better to wash the carcass with water to remove all blood before it is immersed in the saline solution. This prevents the latter from being discolored and the worms are easily seen and removed.

The use of the warm saline solution bath has proved to be very successful in the collection of unharmed adult filarial parasites. The same method will be given a trial in the collection of other forms of endoparasites.

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# SOCIETY PROCEEDINGS

## ABSTRACTS OF PAPERS CONTRIBUTED FOR THE SEVENTH ANNUAL MEETING OF THE AMERICAN SOCIETY OF PARASITOLOGISTS, NEW ORLEANS, LOUISIANA, DECEMBER 29, 30 AND 31, 1931

*Yeast as a Factor in the Growth of the Fowl Nematode* Ascaridia lineata (*Schneider*). James E. Ackert and T. D. Beach, Department of Zoology, Kansas State College.

The results of experiments on the vitamin B complex as a factor in the resistance of chickens to *Ascaridia lineata* (Schneider) suggested the possibility of yeast containing a special growth factor for this intestinal nematode. In two experiments involving 262 chickens, the young birds were raised during the first month on an adequate diet in which the vitamin B complex was supplied in oats (Otona). At the end of a month, the chicks were separated into three groups of equal size and weight as follows: Group 1 (controls) kept on the regular diet; Group 2, regular diet plus 6 per cent of brewer's yeast; and Group 3, regular diet plus 20 per cent of baker's yeast, which due to the moisture content was equivalent to approximately 6 per cent of dry yeast. After one week (Experiment I), or four weeks (Experiment II) the chickens were parasitized by being fed 50 embryonated eggs of *A. lineata.* At the close of three weeks of parasitism the chickens were killed and the worms isolated from each intestine and measured. The results showed that there were no constant differences either in the lengths or in the numbers of the *A. lineata,* between those from the control groups and the nematodes from the brewers and bakers groups, indicating that in the presence of an adequate amount of the vitamin B complex, yeast does not furnish a special growth factor for the fowl nematode, *A. lineata.*

*Viability of the Eggs of the Fowl Nematode* Ascaridia lineata (*Schneider*) *Exposed to Natural Climatic Factors.* James E. Ackert and George E. Cauthen. Department of Zoology, Kansas State College.

Tests on the viability of the eggs of the fowl nematode *Ascaridia lineata* (Schneider) exposed in soil to natural climatic factors have been carried on at Manhattan, Kansas, during the last eight years. Summer exposures of ova at less than ½ in. of unshaded soil were lethal in three weeks, but in shaded situations, similar to those about drinking fountains, the ova remained viable from spring to autumn. At depths of 2 to 6 in. the viability increased markedly, especially with normal precipitation which also affords protection by providing subsoil moisture. Eggs exposed in the autumn (October) do not become infective before winter. In 2 in. or less of soil, the eggs fail to survive normal winters (with sub-zero weather), but may live through mild winters. Spring exposures provide infective eggs at all depths by May and June, just in time for the late baby chicks which are the ones that suffer most from ascaridiasis. Of the various stages of development the unsegmented ovum is the most resistant to lower temperatures (0° to 6°C.) in a high relative humidity. The next most resistant stage is the coiled embryo; the intervening stages are the least resistant. This is attributed to the rate of metabolism; the slower the rate, the greater the viability.

*Effects of Periodic Bleeding on the Resistance of Chickens to the Intestinal Nematode,* Ascaridia lineata (*Schneider*). James E. Ackert and Dale A. Porter, Department of Zoology, Kansas State College.

Two experiments involving 300 young chickens were carried out to ascertain if periodic bleeding would affect the resistance of the fowls to the growth of the intestinal nematode, *Ascaridia lineata* (Schneider). In each experiment the chickens were separated into two equal groups, A and B. Those in group A were bled at weekly intervals, the volume of blood taken being increased from ½ cc. when the chickens were 4 weeks old to 1 cc. at the fifth week, 2 cc. at the sixth week and so on until the ninth week when 5 cc. of blood were taken. Those in group B served as controls. At six weeks of age each chicken in both groups was parasitized with embryonated eggs of *A. lineata* as follows: 500 eggs to each chicken of Lots 1A (bled) and 1B (control), 300 to Lots 2A and 2B, 100 to lots 3A and 3B, 50 to Lots 4A and 4B, and 25 to Lots 5A and 5B. After three weeks of parasitism the chickens were killed, the nematodes isolated from each bird, and measured. The worms from Lot 1A and Lot 2A were significantly longer than those from Lot 1B and Lot 2B. While the differences between the other lots were not significant, the worms from the remaining lots bled were longer than those from the controls. These results indicate that the periodic bleeding affected the growth inhibiting mechanism, lowering the resistance of the chickens to this parasite.

*Life History of the North American Lung Fluke of Mammals.* Donald J. Ameel, University of Michigan.

Microcercous cercariae from the snail *Pomatiopsis lapidaria* have been experimentally proved to be the cercariae of the North American lung fluke. Average measurements in microns of formalin specimens: total length, 178; width, 93; tail, 15 by 14; oral sucker, 48; stylet, 39 by 7; acetabulum, 34 by 47. Body and tail spinous, spines longest at posterior end of body and tail (very conspicuous at tip of tail). Unicellular cuticular glands scattered over body. Fourteen penetration glands situated anterior to posterior border of acetabulum, occur in two lateral groups of four cells each and two of three each in the mid region. Ducts grouped in four trunks. Twelve ducts located with certainty, existence of two ducts doubtful. Absence of these two may indicate that two cells are not penetration glands. Prepharynx long; pharynx located about midway between suckers. Digestive ceca undifferentiated. Brain butterfly-shaped, between oral sucker and pharynx. Genital primordium a broad mass of cells posterior to acetabulum. Excretory bladder median, thick-walled, occupying region between genital primordium and posterior end of body. The noticeable differences between this cercaria and existing descriptions of the cercaria of the Asiatic lung fluke may indicate that these are distinct species. Redia elongated ellipsoidal, without appendages; mouth terminal, leading into a large muscular pharynx; esophagus short and narrow; gut short, usually spherical, often smaller than pharynx. Birth pore adjacent to pharynx. The cercariae infect crayfishes, localizing in the heart tissues. The mink is the normal definitive host.

*Host Specificity in* Balantidium coli. Justin Andrews, School of Hygiene and Public Health, Johns Hopkins University.

Balantidia from man have been successfully transferred by the author to pigs, guinea-pigs, and rats but not thus far to monkeys, rabbits, cats, dogs, lambs, or kids. Balantidia from pigs have been successfully transferred by the author to rabbits, guinea-pigs, and rats but not thus far to monkeys. Balantidia from the

guinea-pigs have been successfully transferred by the author to rats, but not thus far to rabbits or monkeys. The evidence here presented emphasizes the similarity between the balantidia found naturally in man and pig, but is not regarded as sufficient to relate to the same degree the balantidia from the guinea-pig to those from man and pig.

*Observations on the Life History of Chilomastix.* Gordon H. Ball, Department of Biology, University of California at Los Angeles.

In a series of experiments running over several years, involving the cultivation of *Chilomastix mesnili* on a number of standard culture media, there was no evidence of anything approaching a life cycle; and no cysts were ever found. The standard culture media were modified in the following ways with the aim of producing encystment *in vitro:* (1) increased viscosity of the medium by gradual evaporation or by the addition of agar, gelatin, or gum arabic; (2) increased concentration of substances normally present in the feces; (3) addition of sterile rice starch or of sterile rice flour to the medium; (4) cultivation on N.N.N. medium; (5) bringing the cultures to room temperature, either abruptly or gradually; (6) alteration in the hydrogen-ion concentration of the medium. None of these modifications produced encystment of Chilomastix in culture. *Chilomastix mesnili* does not grow in culture at a $p_H$ below 4.0 or above 9.0. Hegner's results in transferring Chilomastix and other mammalian protozoa to young chicks have been amply confirmed for this flagellate. The chick cecum, for a time at least, offers a particularly favorable environment for Chilomastix, these flagellates being found frequently in relatively greater numbers in the chick than in the original host or on artificial culture media. Encystment of Chilomastix occurs occasionally in the chick, but offers the same difficulty in determining the causes which bring it about as does the process in the normal host.

*Two Species of Coccidia from the Norway Rat.* E. R. Becker and P. R. Hall, Iowa State College.

*Eimeria miyarii* Ohira, 1913, and another Eimeria from the wild Norway rat were cultivated separately in the albino rat. The former species corresponds closely to the description by Pérard (1926). The oocysts of the new Eimeria are predominantly ellipsoidal in shape, and measure from 13.1 to 23.8$\mu$ in length and from 11.4 to 18.0$\mu$ in breadth; average size, 18.0 by 14.6$\mu$. Under optimum conditions, sporulation is completed in less than 36 hours. The "prepatent" period is five days, the "patent" period not over four days. The new species is being described elsewhere and in more detail under the name *Eimeria separata.*

*Host Feeding in its Relation to Parasite Reproduction in Avian Malaria.* George H. Boyd, Department of Zoology, University of Georgia.

In previous reports (1929), the author has shown that the marked periodicity which characterizes *Plasmodium cathemerium* in its reproductive activity is determined to a certain extent by conditions in the environment of the parasite. The present paper deals with a continuation of former studies in which the object is that of determining the influence, if any, of host feeding over the reproductive activity of this organism. The method followed was that of making various modifications in the feeding time of female canaries infected with *P. cathemerium* and following the reproductive activity of the parasite under such treatment. Seventy infections have been studied in this way. The results seem to indicate that feeding, though not the only factor involved, is one of the factors which serve to bring about the definite periodicity which usually characterizes the reproductive activity of this parasite.

*Clinical Experiences with Hexylresorcinol against Ascaris, Hookworm, Trichuris, Enterobius and Taenia.* H. W. Brown, School of Medicine, Vanderbilt University.

Over 2,200 cases harboring ascaris, hookworm or trichuris have been treated by using crystalline hexylresorcinol. This drug is now given in pill form and removes at a single dose over 90 per cent of the ascaris, 80 per cent of the hookworm and 50 per cent of the trichuris. In one series of 200 ascaris cases 75 per cent were negative after one treatment. A comparison is made with the results of other workers using hexylresorcinol in Ceylon, Samoa, Guatemala and the United States. A limited number of Enterobius and Taenia cases have been treated with favorable results.

*Susceptibility and Resistance in Helminthic Infestations.* Asa C. Chandler, Rice Institute. (This paper is the retiring address of the acting president.)

A review of recent work on the acquisition and course of helminthic infections in normal and abnormal hosts, with particular reference to such factors as age, diet, preexisting infection, and repeated or continuous reinfection.

Ornithostrongylus quadriradiatus *of Pigeons; Observations on Its Life History Pathogenicity and Treatment.* Eloise B. Cram and Eugenia Cuvillier, Zoological Division, Bureau of Animal Industry, United States Department of Agriculture.

In epizootics in three flocks of pigeons the onset was sudden and mortality very high. Principal symptoms were droopiness, inability to walk without pitching forward, profuse greenish diarrhea, consumption of excessive amounts of water, refusal of food or, if food was accepted, its regurgitation with green fluid. As many as 1600 worms were collected from one bird. Wall of small intestine markedly affected by worms which may penetrate villi to fully one-half their depth. Considerable numbers of immature worms may be present in proventriculus, having penetrated deeply. As regards life history, the eggs hatch as early as 21 hours and as late as 9 days in the same culture. Larvae were found to be infective as early as 3 days and as late as 5 weeks thereafter. They have considerable resistance to cold and to drying. In experimental infections, symptoms were most severe and deaths most frequent 2 to 5 days after infection, while the worms were still immature, eggs not appearing in droppings until the 7th day. For treatment tetrachlorethylene holds considerable promise. Thymol also was tried but with less success. Attempted infection of the chicken, turkey and guinea fowl gave negative results.

*A New Cystocercous Cercaria with Notes on Its Life Cycle.* E. E. Dickerman. Department of Zoology, Northwestern University.

A large number of cystocercous cercariae of the Mirabilis group were obtained from snails from the Des Plaines River near Evanston, Illinois. This cercaria differs from species heretofore described with respect to esophagus, ceca, uterus, position of genital organs, presence of receptaculum seminis, extent of vitellaria and excretory system. Sporocysts were found in the mantle chamber of snails. Development is asexual. The distome is attached to end of tail of cercaria during development and enters tail just before emergence of cercaria. Fish and frogs were experimentally infected.

*Recent Developments in the Transmission of Endemic Typhus.* Walter E. Dove. Bureau of Entomology, United States Department of Agriculture. (Invited paper.)

Recent reports by different workers on endemic typhus suggest that the organism of this disease has a weak host-specificity. This paper is a consideration of the ecto-parasites of the rat and of the rodent reservoir for the infection of man. It

reviews the work on transmission of endemic typhus through the bites of tropical rat mites, the work of Dyer and his associates on rat fleas, and the work of Zinsser and his associates on bed-bugs and lice of rats.

*Some Peculiar Relationships Between Ectoparasites and Their Hosts.* Henry E. Ewing, Bureau of Entomology, United States Department of Agriculture.

Lice appear to lack the faculty of detecting their natural host. Thus the louse of the gray spider monkey, *Ateles geoffroyi,* when transferred to man readily fed. Likewise those of a baboon-like monkey, Magus sp., readily took to man and fed; and the sucking louse of the dog, *Linognathus piliferus,* sucked the blood of man. In all these cases, however, the lice soon died after feeding.

It is believed that differences between species of biting lice have arisen largely because of isolation on very similar hosts. If these hosts were not isolated would they have developed their own peculiar species? Nature herself has performed an experiment settling this question for the cuckoos and cowbirds. The young of these birds find themselves squeezed among nestlings of various sorts where conditions for the transfer of parasites are optimum. Our common cowbird, *Molothrus ater,* lays its eggs in the nests of 158 species of birds, yet it is only moderately parasitized, and its lice are characteristic only of those birds belonging to the same family as the cowbirds. The kangaroo-dog-louse, *Heterodoxus longitarsus,* has passed from its original host, the kangaroo, to the dog, finding on the latter the proper "ecological environment." Only man and the gorilla are infested with Phthirus species, constituting the family Phthiridae. If crab lice, Phthirus species, have evolved upon the great apes and man, as apparently they seem to have done, then this evolutionary period must have been long enough to develop family characters in these two louse species.

*The Effect of a Deficient Diet on the Susceptibility of Dogs and Cats to Non-Specific Strains of Hookworms.* A. O. Foster and W. W. Cort, School of Hygiene and Public Health, Johns Hopkins University.

Dogs that were kept on a deficient diet for considerable periods of time became susceptible to infection with the cat strain of *Ancylostoma caninum,* to which they had been extremely resistant while on an adequate diet. Cats also that were kept on a deficient diet partially lost their resistance to the dog strain of *Ancylostoma caninum.* These findings are of interest in connection with experiments reported elsewhere, which showed that the resistance of dogs to infection with the dog strain of *Ancylostoma caninum* which had been produced by age and previous infections, could be completely broken down by placing the animals on a deficient diet. On the other hand in a considerable series of old dogs kept on the deficient diet, attempts to produce infection with the human hookworm, *Necator americanus,* were unsuccessful.

*The Relation of Diet to the Susceptibility of Dogs to* Ancylostoma caninum. A. O. Foster and W. W. Cort, School of Hygiene and Public Health, Johns Hopkins University.

Studies on nine dogs carried over considerable periods of time gave an experimental demonstration of a definite correlation between undernourishment and susceptibility to infection with the dog strain of *Ancylostoma caninum.* The deficient diet resulted in a breaking of the resistance to infection in animals that had developed a very great resistance due to previous infection and age. There was also an increased rate of development of the worms and a greatly increased egg production of the females. When the dogs that had acquired an infestation while on the deficient diet were transferred to a good diet their recovery of resistance was indi-

cated by a reduced egg production of the worms present, a spontaneous loss of worms which in certain cases amounted practically to a dietary cure and the development of a resistance to further infection. It seems possible from this and other evidence that a similar relation may exist between the hookworms of man and their hosts. We advance as a working hypothesis the view that in human hookworm heavy infestations may be more easily built up in people on deficient diets, and that not only the injury of the worms to their hosts may be reduced, but also that the worms themselves may be partially or wholly eliminated by improvement in diet alone.

*The Seasonal Life History of* Anopheles maculipennis *with Reference to Humidity Requirements and "Hibernation."* Stanley B. Freeborn, University of California.

Systematic collections of both larvae and adults of this malaria carrier in California have demonstrated the presence of a June-July generation of larvae which is not reflected in the adult collections. Laboratory trials substantiate the belief that the low humidity conditions at this season reduce the life span of the adults to a period sufficient for egg production but insufficient to transmit malaria or build up the adult population. In the late fall two types of adults are produced—(1) a normal non-migrant summer type form which feeds, develops and lays eggs, and dies, and (2) a more robust, melanotic migrant form which feeds but develops fat body instead of ovaries and passes the winter in hiding.

*A Comparative Study of the Male Terminalia of Californian Anophelines.* Florence M. Frost, University of California.

The male terminalia of *Anopheles punctipennis* Say, *A. pseudopunctipennis* Theobald, and of *A. maculipennis* Meigen are described from specimens mounted in Gater's medium.

*A Survey of Flies, Pigs, Fowls, Rats and Mice in a Rural Community for the Intestinal Protozoa of Man.* William W. Frye and Henry E. Meleney, School of Medicine, Vanderbilt University.

In a rural community in Tennessee, in which an epidemiological study showed a high incidence of *Endamoeba histolytica* without much evidence of clinical dysentery, studies are now being made of the possible sources of infection and modes of transmission. Flies were collected in and about houses and their droppings and intestinal contents examined for protozoan cysts. In collections from twelve houses containing carriers, cysts of *E. histolytica* were recovered from four, *E. coli* from seven, *E. nana* from one and *Giardia lamblia* from two. Two of the collections showed both *E. histolytica* and *E. coli* and one showed *E. histolytica, E. coli* and *E. nana.* Fecal specimens were collected from 127 pigs on 27 farms. Cysts having the morphological characteristics of the following protozoa were found on microscopic examination in the number of pigs indicated: *E. histolytica* 1, *E. polecki* 80, *E. nana* 7, Iodamoeba 31, Chilomastix 3 and Giardia 1. To date 34 wild rats, 30 gray mice and 36 fowls have been examined. No human protozoa have been found to date in any of these animals. These observations suggest that *in this community* flies may be an important source of spread of human intestinal protozoa; that these protozoa are destroyed in passing through fowls and that as far as our observations go pigs, rats and mice do not act as reservoir hosts.

*Parasites in Northern Michigan.* William G. Gamble, Jr., Mercy Hospital, Bay City, Michigan.

(No abstract received.)

*A Pathogenic Nematode of the Japanese Beetle.* R. W. Glaser, Department of Animal and Plant Pathology, The Rockefeller Institute for Medical Research, Princeton, New Jersey.

Fox and the writer (1929) reported the occurrence of an oviviviparous nematode which killed large numbers of Japanese beetle grubs in one locality in New Jersey where a pronounced reduction in the beetle infestation had been noticed within recent years. Appropriate laboratory tests have demonstrated the parasitic nature of this round worm. Steiner placed it among the Oxyuridae, describing the form as a new genus and species under the name of *Neoaplectana glaseri.* Since that time the entire life cycle of Neoaplectana has developed on a special yeast medium. This greatly facilitated the study, and also led to economic possibilities. The beetle grubs ingest the second stage larval parasites. The first stage forms, the pre-adults and adults are incapable of producing infections. The invasive form, after ingestion, rapidly matures and the oviviviparous females give birth to many young which leave the host after death as second stage larvae. Dead grubs often swarm with Neoaplectana, most of them in the second stage. On the medium the life cycle may be completed in five days; death of a beetle grub may occur in from one to two weeks after infection. Experimental infections produce a mortality of from 40-80 per cent. Second stage cultured forms were introduced into field plots containing known beetle populations and the laboratory experiments were reproduced Field evidence has been obtained, directly by estimating grub mortality and by adult emergence counts, and indirectly by noting the extent of beetle damage to the vegetation. The field work is being continued.

*Some Studies on the Breeding Media, Development and Stages of the Eye Gnat* Hippelates pusio *Loew, (Diptera: Chloropidae).* D. G. Hall, Bureau of Entomology, United States Department of Agriculture.

The eye-gnat, *Hippelates pusio* Loew, is well distributed over the southern United States and is particularly abundant in southern California where it is a real menace to the health of the residents of Coachella Valley. In this locality the adults are present during the entire year but are most abundant in the spring and fall months. Oviposition may occur throughout the year, the eggs being deposited singly and promiscuously on or near the larval food. The incubation period varies with the temperature and moisture, averaging about 3.66 days during favorable seasons. The larvae are capable of developing in a number of decaying materials and excrements. On human excrement the length of the larval stage averaged about 11.3 days; upon dog manure the length of the stage averaged about 8.71 days and upon decaying oranges about seven days. Fermenting or sour substances were unfavorable for larval growth. They developed readily on excrement and upon materials in advanced stages of decay. Figs were found unfavorable when sour but favorable when decomposed. Pupation occurs either in the food upon which the larvae develop or in the sand surrounding such media. The depth in the media at which pupation occurs depends upon the amount of moisture present. The average pupal stage was found to be about 9.84 days. These studies suggest that the problem is one of sanitation as well as one of agricultural practices.

*The Preparation and Editing of Papers on Parasitology.* Maurice C. Hall, Zoological Division, Bureau of Animal Industry, United States Department of Agriculture.

Papers on parasitology should be prepared with reference to existing conditions the uses to which the paper will be put, and the needs of those who will read or use the paper. Among other existing conditions is shortage of space available for publication of papers on parasites; this calls for such abbreviation of papers as is consistent with presentation and analysis of the data, and the drawing of conclusions. Among the uses of papers are utilization of morphological, experimental and

other data as a basis for comparative studies and as a hint for new work; this calls for uniform arrangement. Among the needs of cataloguer, indexer, and reviewer or abstractor are such mechanical devices as will simplify the work of these persons and ensure that salient things involved in the presentation will stand out and not be overlooked. The basic elements of unity, coherence and emphasis should be kept in mind and certain common errors and vagaries avoided.

The perennial conflicts between editors and authors should be diminished by a mutual understanding as to the rights and duties of both groups. It should be kept in mind that certain matters are entirely the business of the editor and others the business of the author; debatable matters should be made a matter of agreement. The object of both groups is to have papers appear in print with the minimum of errata of all sorts and in the form which will make the paper as readable and usable as possible.

*Helminths Parasitic in the Amphibia and Reptilia of Houston, Texas, and Vicinity.* Paul D. Harwood, Rice Institute.

In this study over five hundred animals representing 50 species were collected and examined. The adult helminths encountered have been placed in sixty species which are distributed among the classes as follows: trematodes twenty-eight species, cestodes nine species, nematodes twenty-two species, and thorny headed worms one species. As might be expected among such a group of worms, there were many new species and one new genus. Furthermore, three genera, Mesocoelium, Oochoristica and Thubunea, have been reported from North America for the first time. The paper, as read, will be a summary in which many of the species will be mentioned by name only so that there will be time for additional remarks concerning the more interesting forms.

*Life History of Spiroxys sp. from American Turtles.* Leslie Hedrick, University of Michigan.

Adult nematodes threaded in stomach mucosa of turtles; pitted ova leave females in one-cell stage, pass out of host in 4-16 celled stage; first stage larvae emerge in 4-7 days; larvae have sheath, anterior of which usually becomes attached to débris or rocks; worms display lashing movement. Many species of cyclops ingest larvae but development has been observed only in *Cyclops leukarti, C. serrulatus, C. albidus,* and *C. viridis* var. brevispinosus; sheath digested in alimentary tract of cyclops, worms penetrate by aid of cuticular tooth into body cavity; larvae when 1-2 mm. long (after 7-12 days) moult, shedding cuticular tooth. Second intermediate hosts: fish (*Umbra limi* and *Ameiurus nebulosus*), tadpoles and larval newts in which larvae are loosely encysted in mesenteries surrounding alimentary tract, and dragonfly larvae in which worms are encysted in somewhat chitinous cysts beneath chitin wall. Larvae penetrate into stomach wall of final host, remain "tissue parasites" for some time. Experiments to determine whether a second intermediate host is facultative or obligatory are in progress. These worms are different from any recognized species of Spiroxys. Before assigning them to specific rank, I am awaiting some of Leidy's material with which to compare my specimens. Walton, 1927, "A Revision of the Nematodes of Leidy's Collection," made Leidy's *Ascaris sulcata,* from the stomach of *Chrysemys picta,* synonomous with *Spiroxys contorta* (Rudolphi, 1819). If my specimens are con-specific with Leidy's *Ascaris sulcata,* then my material will be designated as *Spiroxys sulcata.*

*Studies on Amoebiasis in Panama.* Robert Hegner, School of Hygiene and Public Health, Johns Hopkins University. (Invited paper.)

This report presents work done by the author in collaboration with Drs. Carl Johnson and Robert Stabler at the Gorgas Memorial Laboratory in Panama. The

following types of *Endamoeba histolytica* are recognized on the basis of morphology and location (1) tissue amoebae, (2) lumen, (3) precystic, (4) stool, (5) degenerate, (6) cysts. Cysts with one or two nuclei when passed continued to develop in the raw feces at room temperature (about 85°F.). Cysts with one or two nuclei, as well as with four, were found to excyst in the small intestine of monkeys into the stomach of which they had been injected per os three hours previously. Infections were set up in four species of monkeys with trophozoites or cysts from man. Howler monkeys were infected by injecting trophozoites per rectum and cysts per os; marmosets and white-faced monkeys with trophozoites per rectum and red spider monkeys with cysts per os. Lesions resulting from these infections were obtained from freshly killed monkeys and preserved immediately. A lesion in a human appendix was available for comparison. The amoebae appear to penetrate the mucosa by mechanically forcing their way between the cells during which process no cellular reaction takes place. Bacteria seem to play a minor rôle in the formation of ulcers. The older ulcers correspond very closely to those described in man by Councilman and Lafleur except that in our monkeys there was an intense cellular reaction to the invasion of the submucosa.

*A Comparative Study of the Eggs of Californian Anophelines.* W. B. Herms and Florence M. Frost, University of California.

Detailed descriptions with illustrations are given of the eggs of the three species of Anopheline mosquitoes occurring in California, namely *Anopheles maculipennis* Meigen, *A. punctipennis* Say and *A. pseudopunctipennis* Theobald. The eggs of these three species differ so markedly that the characters observed may be safely used to differentiate the species. An account is also included of the number of eggs deposited per female for each species.

*Some Effects of Parasites on the Metabolic Rate of Their Hosts.* C. A. Herrick, University of Wisconsin.

The metabolic rate of rats, infected with *Trypanosoma equiperdum* and allowed access to food for two hours daily, varied directly with the number of trypanosomes. The increase in the metabolic rate of the infected animals was significantly higher than it was before the infection and that of the uninfected controls. When rats were infected following a fasting period of 48 to 120 hours the increase in their metabolic rate during the infection was significantly less than it was for unstarved animals. If rats were given a number of trypanosomes sufficient to cause death in from one to three hours, the increase in metabolic rate was not as great as when the infection had continued for several days following a light inoculation. When animals were inoculated with *Trypanosoma equiperdum* under such conditions that the infection reached a crisis and the number of trypanosomes decreased to rise to a second crisis, the metabolic rate varied with number of trypanosomes except for the rise at the second crisis. At this point there was only a slight increase in the metabolic rate of infected animals.

The machine used in these studies is of the closed system type. It consists of five units, therefore making it possible to run infected and control animals simultaneously. As the machine may be recharged while readings are being made, consecutive runs of any duration may be made indefinitely. It is therefore possible to study the animal continuously from the time of inoculation to death.

*The Utilization of Material in Solution by Aquatic Animals, with Especial Reference to Mosquito Larvae.* E. Harold Hinman, School of Medicine, Tulane University of Louisiana.

(No abstract received.)

*Experimental Transmission of an Unusual Haemoproteus of Mourning Doves.* Clay G. Huff, University of Chicago.

*Haemoproteus sacharovi* Novy and MacNeal, a large parasite of mourning doves, was regarded by Sacharoff as a leucocytozoon. It differs from most species of Haemoproteus in that the gametocytes are oval or oblong. They completely fill the infected red cells and enlarge them to a size averaging 1.3 times as wide and 1.4 times as long as the normal red cell. The red cell nucleus is pushed to the outer edge where it appears as a cap. The parasites are common in doves caught in Illinois. Adults of *Pseudolynchia maura* were bred from puparia and placed upon a mourning dove infected with *H. sacharovi.* These flies were removed after 2, 3, and 5 days and placed on normal pigeons. Thirteen days later the pigeons were found to be infected with a Haemoproteus identical with the one in the dove. The particular Hyppoboscid fly responsible for natural transmissions is yet unknown.

*Effect of Five Species of Eimeria Upon Egg Production of Single Comb White Leghorns.* W. T. Johnson, Oregon State Agricultural College.

Experimental inoculation of mature, highly susceptible S. C. White Leghorns, with large doses of pure cultures of *Eimeria mitis* Tyzzer, *Eimeria praecox* Johnson, *Eimeria acervulina* Tyzzer, *Eimeria maxima* Tyzzer and *Eimeria tenella* Railliet and Lucet was followed by a slight average decrease in egg production by the groups inoculated wtih *E. mitis* and *E. praecox* and complete temporary cessation of production by the surviving fowls inoculated with *E. acervulina, E. maxima* and *E. tenella.* This decrease followed closely the prepatent periods of the respective species. The fowls, numbering 65, varied from 351 to 432 days of age when inoculated. They were distributed among three rooms. The first room contained 40 fowls, all running together, 10 of which were controls and the remaining 30 divided into five groups of six. Each group of six was inoculated with a single species of Eimeria. The second room contained 13 fowls, 10 of which were inoculated with *E. maxima* and later with *E. mitis.* The third room contained 12 fowls, nine of which were inoculated with *E. acervulina* and later with *E. praecox.* The fowls were kept on wire in the house and fly-screened yards, except during early life. Roofing paper covering part of the floor at first was cleaned with hot water twice daily. Trap-nests were provided with wire bottoms. No evidence of accidental infection was found previous to experimental inoculation.

*Incidence of Intestinal Protozoa in Arthritic and Non-Arthritic Patients in a Hospital Population.* John F. Kessel, School of Medicine, University of Southern California.

Since it has been suggested that intestinal protozoiasis and especially amoebiasis may be factors in producing chronic arthritis, data have been collected in the Los Angeles General Hospital from patients exhibiting chronic arthritis which may be compared with corresponding figures from non-arthritic patients in the same institution. An average of 5.6 stools per patient from 442 arthritic cases and an average of 3.8 stools from 5439 non-arthritic patients were examined. The percentages of positive findings are as follows, the arthritics being recorded first and the non-arthritics second: *Endolimax nana,* 16.3-12.2; *Entamoeba coli,* 14.9-11.4; Chilomastix, 10.4-6.6; *Councilmania lafleuri,* 6.9-3.6; *Entamoeba histolytica,* 5.4-6.4; Trichomonas, 4.7-4.7; Giardia, 4.1-3.8; Iodamoeba, 2.7-1.9. The arthritic patients show a positive incidence for all protozoa of 39 per cent and the non-arthritic an incidence of 27.2 per cent. Since the arthritic patients received more examinations per patient than the non-arthritic, this higher incidence does not appear to be of great significance. These results, therefore, do not lend significant supporting evidence to the assumption that patients suffering from chronic arthritis exhibit an appreciable higher incidence of infection with *E. histolytica* or other intestinal protozoa than non-arthritic individuals.

*The Chemotherapy of Intestinal Helminth Infestations.* Paul D. Lamson, School of Medicine, Vanderbilt University. (Invited paper.)

A general review of anthelmintics including a comparison of the more important ones with special emphasis on carbon tetrachloride, tetrachlorethylene and hexylresorcinol.

*Observations on* Cyathodinium piriforme, *an Endozoic Ciliate of the Guinea-Pig.* Miriam Scott Lucas, School of Medicine, Washington University.

Three species of Cyathodinium have been described by da Cunha in Brazil. One species so far, *Cyathodinium piriforme,* has been observed to occur sparsely in the caecal content of fifty-two per cent of laboratory guinea-pigs in this country. A morphological and statistical study has been completed upon this ciliate. Data reveal that this species of Cyathodinium may be present in two distinct forms within the intestinal tract of the same host. The specific form maintained by the infusorian is that of a piriform cell. The second form results from a transition of the piriform cell into a conical shaped cell. The second form is related to rejuvenescent and reproductive activities.

*The Course of Experimental Trichiniasis Infections in Rats.* O. R. McCoy, School of Medicine and Dentistry, University of Rochester.

All infections were given to the rats by stomach tube with counted numbers of trichina larvae obtained free from infected muscle by artificial digestion. In light infections (following a dose of approximately 10 larvae per gram of rat) the adult worms were lost from the intestine in about 2 weeks. Muscle examined after 4 weeks contained only encysted larvae. In heavier infections with about 40 larvae per gram, a considerable proportion of the adults remained in the intestine for 3 to 4 weeks or longer, and muscle examined at this time contained larvae in all stages of development. Furthermore, in a series of rats given various sized doses of larvae, the ratio of the total number of larvae which developed in the muscles to the number originally fed was about 200 in the heavily infected rats, whereas in those lightly infected it was only about 100. These figures indicate that approximately 400 larvae were produced per female worm in the heavy infections as compared with approximately 200 per female in the light infections. It is believed that there are host-resistance factors of some sort which limit the duration of the intestinal infection in lightly infected rats. In the heavy infections, this resistance is broken down so that the adult worms persist in the intestine for a longer period of time and compared with the lightly infected rats the resulting muscle infection is much greater than can be explained by the difference in size of the original dose of larvae.

*Skin Reactions to* Trichinella spiralis *Antigen in Cases of Trichiniasis and Infections with* Trichuris trichiura. O. R. McCoy and J. J. Miller, Jr., School of Medicine and Dentistry, University of Rochester.

Intradermal tests with a saline extract of *Trichinella spiralis* were made on 38 proven cases of trichiniasis, 11 cases diagnosed as trichiniasis and 159 control individuals in western New York State, and also on a group of 124 persons in southern Louisiana, 92 of whom were infected with *Trichuris trichiura.* The tests consisted of injections of 0.1 cc. of 1 to 10,000 and 1 to 500 dilutions of the antigen (in terms of dry weight of powdered trichinae larvae). Positive reactions of the immediate type were obtained in 87 per cent of the proved cases of trichiniasis, 46 per cent of the diagnosed cases, 11 per cent of the control individuals and 62 per cent of the persons infected with *Trichuris trichiura.* In the group of proved cases of trichiniasis 25 persons had contracted their infections within the last 2 years. Of these, 24 or 96 per cent reacted positively, whereas of 12 persons who were ill from 2 to 8 years ago only 8 or 67 per cent were positive. The high percentage (62 per

cent) of positive reactions among the persons infected with *Trichuris trichiura* indicates that the intradermal test with an ordinary saline extract of *Trichinella spiralis* cannot be considered specific for trichiniasis.

*A New Species of Tick from the Texas Peccary.* Allen McIntosh, Zoological Division, Bureau of Animal Industry, United States Department of Agriculture.

On a recent visit to Kingsville, Texas, Dr. Maurice C. Hall collected from 5 peccaries, *Pecari angulatus angulatus,* three species of ticks which were identified by the writer as follows: *Amblyomma cajennense, Dermacentor variabilis,* and a species of Dermacentor regarded as new, for which the name *Dermacentor halli* is proposed. A brief diagnosis is as follows: *Male.* Body oval, narrowing anteriorly; scutum 4.38 mm. long, 2.8 mm. wide; ornate; cervical grooves short; marginal grooves shallow, marked by a row of small punctures; remainder of scutum with comparatively few punctures; eleven festoons. Capitulum and legs marked with white; cornea long; palps short and broad. Spiracle comma-shaped with broad tail; goblets small, numerous. Coxa I with two well separated spurs of equal length; femur IV armed ventrally. *Female.* Body brownish-red; scutum 1.79 mm. long; 1.95 mm. wide; ornate, with few punctures; broadly rounded from eyes to apex. Capitulum and legs marked with white dorsally; cornua of medium length, porose areas oval, close together, diverging anteriorly. Spiracle similar to that of male. Spurs of coxa I as in male. The following combination of characters will aid in separating *D. halli* from the other American species of Dermacentor: The absence of numerous, deep, large punctuations on shield; the equal length of the well separated spurs of coxa I; the broad postero-dorsal prolongation of the stigmal plate; and the broad and posteriorly rounded shield of the female. A key to the American species of Dermacentor is given.

Trichomonas vaginalis. Thomas Byrd Magath and L. Mary Moench, Mayo Clinic, Rochester, Minnesota.

This is a summary of observations made upon the parasite and upon patients harboring the parasite. The incidence, relation to vaginal pathology, significance of finding the parasite in the urine and observations concerning the mode of infestation and methods of diagnosing and treating the disease are discussed.

*Some Abnormalities of Trematodes.* H. W. Manter, University of Nebraska.

Monorchism is probably the most common abnormality among trematodes. Monorchism, as an anomaly, has been described for at least nine species belonging to six different families. To this list can be added *Podocotyle atomon* and a Podocotyle sp. from *Scorpaena cristulata* (a marine fish). One specimen of *Podocotyle atomon* showed both testes lacking, a very unusual condition but also occurring in *Helicometra execta.* A mutilated and regenerated specimen of *Helicometra torta* showed the loss of one testis due apparently to mechanical injury. A specimen of *Lecithochirium synodi* was so heavily infected with microsporidia as to suppress one testis. Microsporidian infection also occurred in *Sterrhurus monticellii* (Linton) and *Sterrhurus laeve* (Linton) from marine fishes. In some trematodes the vitelline glands become locally or generally disorganized. A peculiar egg malformation was seen in Didymozoon sp. The oral spines of Stephanochasmus species sometimes show malformations due perhaps to injury and regeneration. Several small spines appear to replace a large one.

*The Effect of Quinine and Plasmochin on Canary Birds Infected with* Plasmodium rouxi, *with Further Notes on the Action of These Drugs on the Other Avian Malarias.* Reginald D. Manwell, Syracuse University.

*Plasmodium rouxi,* a malarial parasite of Algerian sparrows, recently described by the Sergent brothers and Catanei (1928) has been studied and found to be more susceptible to quinine than any of the other three species of avian plasmodia. It appears to be as susceptible to plasmochin as *Plasmodium elongatum.* Treatment

for two weeks, beginning the day after inoculation, will entirely prevent development of the infection, and sterilization can be brought about in apparently all cases by the same treatment when started after the acute stage of infection has developed. The different avian malarias therefore stand in the following order with regard to susceptibility to quinine and plasmochin (experimental work on which this order is based has been previously reported for the other three species): Quinine—1. *Plasmodium rouxi, 2. Plasmodium praecox, 3. Plasmodium cathemerium,* 4. *Plasmodium elongatum;* Plasmochin—1. *Plasmodium elongatum,* and *Plasmodium rouxi, 2. Plasmodium praecox, 3. Plasmodium cathemerium.* It has been found that birds infected with *Plasmodium elongatum* vary considerably in their response to treatment, six days of treatment being sufficient to sterilize some acute cases whereas other cases of apparently similar severity and equal duration could not be sterilized in ten days. Thus it appears that resistance of the bird plays a very important part in the action of the drug. In general, about four days seem necessary to prevent development of infection when treatment is started the day after inoculation with parasites, and about twelve days when it is deferred until the acute stage has begun.

*The Effects of Coccidiosis upon the Weights of Chickens Inoculated During the 7th, 12th and 13th Weeks.* Roy L. Mayhew Agricultural and Mechanical College, Louisiana State University.

Single Comb Rhode Island Red chickens which were incubator hatched from hens free from white diarrhea were used in these experiments. They were reared in a battery brooder, in a steam heated room under closely controlled temperature and sanitary conditions, and all lots received the same brand of commercial feed during the time of the experiments. Weekly weights were taken, and fecal examinations were made in order to determine the freedom of the controls, the severity of the infection, and the course of the disease during the weeks following its appearance. An examination of the weight data show the following results:

When Inoculated During the Seventh Week

| | | % Diff. in Wt. between Inoc. and Controls | | | | |
|---|---|---|---|---|---|---|
| | No. Individuals | 5th Wk. | 8th Wk. | 12th Wk. | 19th Wk. | 20th Wk. |
| Females..... | I–30, C–22 | +5.3 | —17.8 | — 8.0 | —5.9 | —2.7 |
| Males..... | I–30, C–32 | +2.4 | —21.6 | —11.9 | —9.2 | —7.2 |

When Inoculated During the 13th and 14th Weeks

| | | % Diff. in Wt. between Inoc. and Controls | | | |
|---|---|---|---|---|---|
| | No. Individuals | 12th Wk. | 16th Wk. | 20th Wk. | 24th Wk. |
| Females..... | I–22, C–18 | —0.98 | —20.8 | —11.5 | — 9.1 |
| Males..... | I–15, C–12 | +1.6 | —23.7 | —17.6 | —10.1 |

I, inoculated; C, controls.

These results seem to indicate that when chickens are severely infected their weights are definitely affected, and that they are not able to recover the loss in weight during the time of these experiments.

*Preliminary Results in the Treatment of Coccidiosis in Chickens with Powdered Buttermilk.* Roy L. Mayhew, Agricultural and Mechanical College, Louisiana State University.

The chickens used in these experiments were from the same flock of hens, and reared in the same manner as those reported upon under the preceding title. The different lots were inoculated on the day following the 6th weekly weight. The regular ration was fed until the 7th day after inoculation. At this time the inoc-

ulated and control chickens were each divided into two groups, and one group of inoculated and one of the controls, given a mash consisting of the regular commercial mash to which 35 per cent of powdered buttermilk was added. The other two groups received the regular commercial mash. No deaths occurred in any of the four groups after the 7th day after inoculation. A comparison of the weekly weight records during the 20 weeks of the experiment does not show an acceleration in the rate of growth of either of the groups receiving the high buttermilk mash when compared with the groups receiving the regular mash.

*Superinfection of Cats with* Taenia taeniaeformis. Harry M. Miller, Jr., Washington University.

Cats from the streets of St. Louis were fed one or more cysticerci (*C. fasciolaris*) of known age immediately after being brought to the laboratory, and were autopsied from two to four days later. A few kittens, infected twice at intervals of one month, were included. Both immature and mature worms were present in 17 animals, and only immature worms in 19 controls. In two of the former group and in three of the controls the cysticerci fed failed to become established. The term "mature" worms has been used to designate those worms which were long and grey in color, which shows that they had been in the intestine for some weeks; in many cases the terminal proglottids were gravid. The immature worms were much shorter and were quite white; they could be distinguished at a glance from the mature worms. The presence in the cat of mature worms has thus been shown not to confer protection against subsequent infection. We have previously demonstrated that the rat intermediate host is immune to superinfection wih *Cysticercus fasciolaris,* the larval stage of *Taenia taeniaeformis;* the cysticercus is a tissue parasite, while the adult stage is an intestinal parasite.

*A New Species of Cyclochaeta from the Ureters and Urinary Bladder of* Esox reticulatus. Justus F. Mueller, New York State College of Forestry, Syracuse University.

A new species of Cyclochaeta, *C. renicola* new species, has been found infesting the pickerel, *Esox reticulatus,* in Oneida Lake, New York. Hitherto Cyclochaeta has been reported only as an ectoparasite, usually on the gills and integument of fishes, with one species on fresh water sponges. *C. renicola,* however, infests the urinary bladder and ureters of the host, being the first member of the genus reported from an endoparasitic location. The infection seems to be specific for *Esox reticulatus,* which is apparently one hundred percent infected in this locality. Extent of damage to the host has not as yet been definitely determined. This species has a diameter of approximately 80$\mu$ and usually has 56 hooks in the skeletal ring.

*What is* Diplostomulum scheuringi? Justus F. Mueller, New York State College of Forestry, Syracuse University, and Harley J. van Cleave, University of Illinois.

We have found in Oneida Lake typical *Diplostomulum scheuringi* in the eyes of perch, sunfish, and large-mouth black bass. From the same location we have a large collection of related Diplostomula which fall into a perfect series showing progressive change in size and in structure. *D. scheuringi* stands as the largest and most advanced form at one end of the series which runs back to small ovoid forms. About six different steps in this series are recognizable. These we believe to represent intergrading stages of development. In the smallest forms, the shape is ovoid but progressive elongation and increase in size leads to the elongate, narrow form of *D. scheuringi.* The shoulder suckers in the smallest forms are invaginated as deep sacs, but with growth these become everted, well-developed

muscular cups. With further development toward the *D. scheuringi* type the suckers undergo involution, until at the end of the series only weakly muscular thickenings remain. Relative internal topography throughout this transition remains constant. It seems probable that these holostomes represent a growth series, rather than a number of different species. The smallest member of the series is similar to, possibly identical with, *D. huronense,* but the status of *D. huronense,* is itself doubtful, as it seems closely similar to *D. browni.* Morover, according to Hughes and Hall, the two forms just mentioned apparently combine two morphologically indistinguishable, but biologically different, species. The need for experimental work in determining the systematics of this group is very evident.

*The Life History of* Leucocytozoon anatis *Wickware.* Earl C. O'Roke, University of Michigan.

*Leucocytozoon anatis,* a parasitic protozoon belonging to the class Sporozoa, infests both wild and domestic ducks in which it causes serious juvenile losses. Gametocytes which are present in the red blood cells are ingested by the female of the blood-sucking black fly, *Simulium venustum.* Gametogenesis, fertilization and oökinete formation take place in the stomach of the fly. Sporozoites develop in oöcysts on the outer wall of this organ. Merozoites develop in schizonts in the lungs, liver, spleen and kidneys of ducks which have been bitten by infected flies. The earliest gametocytes are to be found in the blood cells on the seventh day following the fly bites. On the tenth day the first mature gametocytes are found. Death of a bird may occur at this time but it usually takes place on the twelfth day unless recovery occurs. The time required for the different stages in the sexual cycle of the parasite in the fly has not been determined. Observations indicate that it may take place in as short a time as five days. This would allow fifteen days for the entire life cycle in both the vertebrate and the invertebrate host. There is evidence that all of the merozoites which enter blood cells are capable of developing into gametocytes and that trophozoites do not occur. This life history has been determined experimentally during two summers' work at the University of Michigan Biological Station.

*Ascaris and Trichuris Infestations in the Southern United States.* G. F. Otto, School of Hygiene and Public Health, Johns Hopkins University. (Invited paper.)

In southeastern United States carelessness and ignorance, coupled with generations of isolation in small mountain retreats, have brought about an almost oriental lack of modesty in regard to defecation. The resulting heavy soil pollution by children in dooryards and playgrounds has built up and is maintaining a heavy ascaris burden throughout the mountains. Outside of the mountains ascaris is not generally present because soil pollution even when general is concentrated in woods and outbuildings away from the house rather than near or under the house. Though such pollution spreads hookworm it does not spread ascaris. The common mode of infestation with the latter is a continuous hand to mouth process. In much of southern United States the semi-tropical sun also plays an important part by destroying much potential infection on exposed sand. In Louisiana, however, a minimum amount of soil pollution is maintaining a fairly heavy ascaris burden because here a long wet warm season furnishes the optimum environment for these eggs. Here trichuris, the egg of which is less resistant to drying than that of ascaris, is more widespread than in the mountains where it is confined to local densely shaded moist communities or households. Repeated treatments might eventually reduce the community worm burden but it seems warranted only as a means of gaining the cooperation of the populace. General education with stress on sanitation and hygiene should prove most effective by developing a sanitary and hygienic consciousness along with the raising of the economic and social level.

*The Prevalence of Human Infection with* Trichinella spiralis. Frank B. Queen, School of Medicine and Dentistry, University of Rochester.

Diaphragms secured from 344 consecutive necropsies in Rochester, N. Y., were examined for the presence of the larvae of *Trichinella spiralis* by artificial digestion of approximately 50 gm. portions of muscle. Infants under one year of age were excluded. Fifty-nine (17.5 percent) were found to be positive. In another series of fifty-eight diaphragms from necropsies in Boston, Mass., sixteen (27.6 percent) were positive. Seventy-three of the seventy-five positive diaphragms were sectioned serially dropping 60$\mu$ between each section. Ten or more sections were examined and larvae were found in seventeen cases, or in only 23 percent of the positive (4.2 percent of the total series of 402 cases). Muscle from twenty-nine positive cases was pressed between glass slides and two fields of 4 by 6 cm. were examined directly. Larvae were found in eleven cases, or 38 percent of the positives examined by this method. Living larvae were recovered in about 75 percent of the 75 positive cases. In the others only cysts and degenerated larvae were found. In ten cases both living and dead larvae were present. None of the Rochester patients who were found infected had a history of trichiniasis, but some gave a vague "rheumatic" history. It seems probable that there are many ill-defined cases of trichiniasis which are being overlooked at the present time.

*Some Effects of Splenectomy on the Blood of Carriers of Anaplasmosis.* Charles W. Rees, Zoological Division, Bureau of Animal Industry, United States Department of Agriculture.

Of fourteen cattle and five sheep splenectomized during 1930 and 1931, the following are some of the sequelae. (1) The blood of splenectomized bovine carriers was found to have acquired increased virulence. Five out of six bulls that received blood of splenectomized carriers succumbed to anaplasmosis. On the other hand the infections which followed intravenous injections of blood of non-splenectomized carriers, while severe, were usually not fatal. Of sixty-two hospital cases thus induced during a period of three years, only two were fatal. (2) Splenectomy of sheep that were carriers of bovine anaplasmosis appears to have rendered their blood a-virulent. These sheep were injected about thirty days previous to splenectomy with virulent bovine blood. Before splenectomy the blood of such sheep was virulent for susceptible bovines, after splenectomy it was a-virulent.

In other respects the sequelae of splenectomy at Jeanerette, La., appear to confirm the report of de Kock and Quinlan on splenectomy of domesticated animals in South Africa.

*Intestinal Parasitism, Diagnosis and Treatment with Use of Glycero-Sulphate Solution and Intestinal Lavage with Hot Salt Solution.* Damaso de Rivas, Department of Medical Zoology and Tropical Medicine, University of Pennsylvania.

Two observations repeatedly made probably give clues to a more rational and safe procedure in the treatment of intestinal parasitism: that large doses of salts have been followed by expulsion of parasites, and that in acute febrile infections spontaneous expulsion of parasites has occurred. Both *in vivo* and *in vitro* an exposure of 5-10 minutes at 45°-47°C. will kill any protozoan or metazoan intestinal parasite.

My present method of treatment, as found most useful, follows: Patient receives light supper, purgative at bedtime, enema next morning. For intraduodenal treatment of small gut parasites, pass duodenal tube by mouth till tip reaches duodenum and bile flow is freely established, patient lying on right side. Inject through duodenal tube 1-2 ounces equal parts glycerine and 30 per cent solution magnesium sulphate. Flush intestine with hot salt solution from tank at 52°-55°C. at rate of about 100 cc. per minute; on duodenal arrival temperature is about 45°-47°C.

Liquid used is 1-2 liters. Colonic treatment for large gut parasites: patient lying on right side, introduce rectal tube into descending colon and insert thermometer in rectum. Flush colon with hot solution of copper sulphate 1-5000, of temperature 50°-55°C., at rate of 100-200 cc. per minute; on arrival in colon temperature is about 45°-47°C. By watching rectal thermometer, control temperature which should not exceed 45°-47°C. Liquid used is 1-2 liters.

Diseases amenable to this treatment are tapeworms, hookworms, oxyuris, trematodes, amebae, giardia, trichomonas and other intestinal metazoan and protozoan infestments.

*Delayed Development of a Rat Nematode in Successive Infections.* Benjamin Schwartz, Joseph E. Alicata and John T. Lucker, Zoological Division, Bureau of Animal Industry, United States Department of Agriculture.

The rate of development of *Nippostrongylus muris* in white rats is influenced to a considerable extent by a previous infection of the host with this trichostrongyle. Following recovery from an infection with this nematode, originally acquired percutaneously as a result of the administration of a single dose of larvae, the rat host is in a state of resistance to a second infection. Resistance is shown as follows: The parasites progress more slowly in various locations of the body; usually many are arrested in the lungs with the consequent inability to develop beyond the third larval stage while in these organs; the development of worms in the small intestine is delayed as shown by failure to attain normal size and egg production in periods adequate for maximum growth and egg production following an initial infection. A similar and usually more pronounced resistance is exhibited by rats subjected to consecutive infections following recovery from earlier infections. Delayed development of the worms and decrease in egg production in the second and subsequent infections sharply limit the value of egg output, ascertained by egg counts, as an index to the number of worms harbored by the host.

*The Variability of Egg Output of Infestations of* Schistosoma mansoni *as Compared with Hookworm.* J. Allen Scott, International Health Division, Rockefeller Foundation, and Department of Public Health, Cairo, Egypt.

Total fecal outputs of three Egyptians, aged 10 to 12, showing eggs of *Ancylostoma duodenale, Schistosoma mansoni,* and *S. haematobium,* were collected 30 consecutive days under normal conditions and counted by Stoll's dilution method, using three "small drops" from each of two displacement flasks from each stirred stool. Eggs of *S. haematobium* appeared only in very small numbers. Measured by the coefficient of variation one case with low *S. mansoni* and high hookworm showed slightly but not significantly greater variability in *S. mansoni* than in hookworm, as expressed in eggs per cc. of feces; two showed lower *S. mansoni* variability. Utilizing moving averages of calculated daily egg outputs all cases had less *S. mansoni* variability than of hookworm. Other methods of comparison point to similar conclusions.

Thus these typical infestations of *S. mansoni* have no greater egg output variability than hookworm in the same cases. Although impossible to determine *S. mansoni* egg-worm correlations it would now seem possible to estimate the relative size of infestations. In Egypt's southern delta average infestations of *S. mansoni* produce relatively few eggs as compared with other species for which dilution counts are used. To avoid missing lower grade infestations of possible clinical importance, three slides are counted. Repeated examinations and comparison with other methods show this technique fully as satisfactory for determining incidence of the parasite as any which have been suggested. It has the further advantage of giving an estimation of intensity of infestation of a population group which may be correlated in a measure with the damage done by the parasites.

*A Study of the Eggs of* Moniezia expansa. John W. Scott and Ralph F. Honess, University of Wyoming.

A recent paper by Sinitsin purports to give development of the egg during a period of 45 days after leaving the host. Our observations on this and other Anoplocephaline eggs differ materially and may be of interest. (1) Changes in the pyriform apparatus develop within 13 days instead of 45 days. (2) In most eggs horns of the pyriform apparatus show no evidence of twisting during the drying process; greatest rotation of the horns observed was 180 degrees, not 540 degrees as figured by Sinitsin. (3) No evidence was found that the horns grow unequally, so conducing to rotation. (4) Gravid proglottids in our climate dry to a thin scale in a few days; isolated eggs collapse by drying in a few hours; the embryo resists drying for some time. (5) As drying progresses, the embryo gradually shrinks, probably not surviving beyond three weeks. (6) The shell, derived from the ootype, is highly permeable. The substance of the pyriform apparatus less so. (7) The shell is easily ruptured, especially after drying. Released in this way, the pyriform apparatus can be made to expel the embryo by placing it in tepid or slightly warm water; the bulb swells, then ruptures at the end opposite the horns, the contraction of the capsule forcing out the embryo which soon claws away the embryonic membrane. (8) Sinitsin's view that the horns of the pyriform apparatus are used to bore into the host neglects an important law of physics, action equals reaction.

Leucocytozoon smithi *Infection in Turkeys and Its Transmission by* Simulium occidentale *Townsend.* Louis V. Skidmore, Department of Animal Pathology and Hygiene, University of Nebraska.

A severe outbreak of disease resulting in high mortality occurred, in 1930, in a farm flock of turkeys near Wilber, Nebraska. *Leucocytozoon smithi* were found in great numbers in the blood of nearly all the turkeys. No parasites were found in the blood of chickens, ducks and geese on this farm. Bacteria, as a cause of the disease, were excluded by microscopic and cultural examination, animal inoculations, and feeding procedures. Noninfected turkeys, injected intravenously and subcutaneously with 0.75-1.00 cc. of heavily parasitized blood failed to maintain *L. smithi* in their blood after 28 days. Turkey lice, *Eomenacanthus stramineum* Nitzsch, collected from infected turkeys and used for injection did not produce infection. *Stomoxys calcitrans,* which had fed on infected turkeys, when injected, gave negative results. Likewise, these flies failed to produce infection by their bites. Parts of diseased organs fed to turkeys did not produce infection. Naturally infected birds kept in our stable continue to have *L. smithi* in their blood for eight months. *Simulium occidentale* Townsend which had fed on infected turkeys near Wilber were brought to our laboratory. These flies were ground up in sterile physiological salt solution, and injected intravenously and subcutaneously into noninfected poults. *L. smithi* were found in the blood of two of the three injected birds on the twelfth day, and continue in the blood after the elapse of more than seventy days.

*The Development of* Oesophagostomum longicaudum *in the Pig.* Lloyd A. Spindler, Zoological Division, Bureau of Animal Industry, United States Department of Agriculture.

*Oesophagostomum longicaudum* Goodey, 1925, originally described from swine in New Guinea, is a common parasite of hogs in the southeastern part of the United States. According to Schwartz, this parasite is associated with a type of intestinal lesion not found in swine in Maryland, where this species is rare and where *Oesophagostomum dentatum* is the predominant species in swine. In order to obtain definite information on the development of *O. longicaudum* in its host, parasite-free hogs were infected by mouth with pure cultures of infective larvae of this species. Forty-eight hours later encysted parasites were found in the mucosa of the large intestine. Each cyst contained a single larva and was surrounded by

an area of intense inflammation with necrosis of the tissues. The exact nature of the cyst wall has not been definitely determined. Seventeen days after infection fourth-stage larvae were present in the lumen of the intestine; some larvae however, were still encysted within the nodules which were raised above the surface of the mucosa and were highly inflamed. Thirty-five days after infection the nodules had almost completely disappeared, the location of each being marked by only a slight thickening of the tissues. Fertile maturity, as evidenced by the discharge of eggs with the feces of infected animals, was attained by the parasites 50 days after experimental infection.

*A Study of Variations in a Single Race of Amoeba from Man Producing Eight-Nucleated Cysts.* Robert M. Stabler, University of Pennsylvania.

Material from a case infected with a single race of amoeba has been studied intensively since November 23, 1929. For one year, from May 8, 1930, an examination was made of every stool passed by the host—398 consecutive stools. As a result of this study, it was found that the organism was intermediate between *E. coli* and *C. lafleuri,* as these have been previously described. The majority of the cysts were found to be off-the-sphere in outline. The cystic nuclei contained ample peripheral chromatin and the karyosomes were for the most part composed of aggregates of granules. In the trophozoites, the nuclei presented all types of variations including crescentic masses, typical of Karyamoebina. The pseudopodial formation is perhaps the most interesting feature. In commencing activity the amoebae invariably began with the formation of clear, explosive pseudopodia, followed in the *same* amoeba, by progressive activity and the formation of granular pseudopodia, with the loss of clear ectoplasm. All the types of variations characteristic of *E. coli* and *C. lafleuri* were found, with the one exception, that not once, despite the many thousands of cysts studied, was budding and the escape of amoebulae ever observed in the saline mounts. Buds were produced at will on the stained slides and the type and temperature of the reagent were seen to be important factors in subsequent bud and ridge formation. From this study it is concluded that there are no significant differences between *E. coli* and *C. lafleuri.*

*Platyhelmia in Aquatic Insects and Crustacea.* E. W. Stafford, Agricultural and Mechanical College, Mississippi.

A report on the immature stages of Trematoda found in aquatic insects and Crustacea including one Cestode from an insect. Trematoda in the abdominal cavity of insects: *Allocreadium tumidulum* (adult) in *Hexagenia variablis. Loxogenes arcanum* in *Plathemis lydia* and *Gomphus villocipes;* adults in frogs from same locality. *Eumegacetes medioximus* in *Gomphus externus,* and *G. plagiatus;* adults procured experimentally in chickens. Prosthogonimus sp. in *Pachydiplax longipennis, Mesothemis simplicicollis* and *Perithemis domitia;* adults produced experimentally in chickens. Lecithodendrium sp. in Perla, Pteronarcys and Corydalis. *Gorgoderina attennata* in *Tetragoneuria cynosura.* Pnuemonoeces sp. in various dragon fly larvae. Trematoda in Cambarus: *Microphallus opacus* in the liver, *Crepidostomum cornutum* in gills, Cephalogonimus sp. in the tail muscles, Maritrema sp. in the gills. Cestoda: Hymenolepis sp. in the abdominal cavity of *Enallagma cyathigerum.*

*Some Practical Considerations in Regard to Control of Hookworm Disease in the United States under Present Conditions.* C. W. Stiles, Washington, D. C. and Winter Park, Florida. (Invited paper.)

We view hookworm disease control in this country from these premises: That many counties lack full-time health organization; that although hookworm disease has decreased in severity, it is still common, while activity in control has decreased;

that in intensifying control, existing machinery should be utilized. An outstanding problem is education of laity, especially to greater appreciation of current work of units advancing rural sanitation; and to greater utilization of existing opportunities for diagnosis and treatment. "Education" suggests local public school machinery, more widespread than the local public health machinery. Children requiring examination and medical treatment for hookworm can easily be classified by teachers into four groups. Three will contain most cases of over a year's duration, the fourth group recent infections. Group I. Children failing school examinations or otherwise not "keeping step." Group II. Children "puny," anemic, undernourished, underfed or underweight. Group III. All girls maturing irregularly or slowly. Group IV. Children with recent dew itch or ground itch, especially during summer vacation. Collect specimens from these children for microscopic examination. The remaining children will contain, true enough, some very light cases and many carriers, but their infection can be taken care of gradually by sanitation. Schools have natural financial and efficiency interest in seeing infected children treated by family physicians or health officer. Even so, it will probably take three more school generations to get hookworm disease under practical control. Great basic problem is changing daily sanitary habits of hundreds of thousands of people, whites, Indians, and Negroes, now living under "dog sanitation" who must be raised to a stage of "cat sanitation."

*Further Studies on the Life History of* Ophiotaenia saphena. Lyell P. Thomas, University of Illinois.

Direct infection of *Rana clamitans* tadpoles was obtained by placing them with *Cyclops vulgaris* experimentally infected with the procercoids of *Ophiotaenia saphena* Osler.

*The Localization of* Giardia canis *(Hegner, 1922) as Affected by Diet.* H. Tsuchiya, School of Medicine, Washington University.

Diet rich in carbohydrates and animal proteins were given to young puppies experimentally infected with *Giardia canis.* Various levels of the intestinal tracts were studied with respect to the numbers and developmental conditions of *Giardia canis.* The duodenum and jejunum were found to be the optimum habitats. On carbohydrate diet, the optimum localization was observed at the levels between 10-30 inches posterior to the stomach, while on a high protein diet, from 25-40 inch levels. With the former, exceedingly few trophozoites were found in the large intestine, while none with the latter. Trophozoites were fewer in the latter than in the former, suggesting that a carbohydrate diet acted favorably for the development of *Giardia canis.* Encystment occurred at the level where the bacterial flora commenced to show a complex type. This condition may be taken as a natural outcome of protective mechanism against unfavorable environment. There were apparently four distinct zones in the intestinal tracts as regards the localization of *Giardia canis.* These were tentatively designated as the zones of multiplication, of optimum localization, of minimum localization and initial encystment and lastly that of encystment.

*The Systematic Position of Some Trematodes from Fresh-water Fishes of North America.* Harley J. Van Cleave, University of Illinois, and Justus F. Mueller, New York State College of Forestry, Syracuse University.

The genera Allacanthochasmus, Acetodextra, Cryptogonimus, and Microphallus have been reinvestigated to determine their relationships. Extensive observations on living material, supplemented by the study of serial sections, have given new evidences of relationship. A distinct gonotyl in Allacanthochasmus, viewed in exserted condition in living worms, shows clearly in sections on the anterior lip

of a ventro-genital sinus, while the acetabulum lies submerged posteriad of the gonotyl and the genital pore. These and other morphological characters indicate that Allacanthochasmus belongs within the family Heterophyidae. The ventro-genital complex of Acetodextra superficially resembles a double acetabulum. The anterior of these bears a gonotyl easily recognizable in sections. In all points, Acetodextra is in agreement with recent characterizations of the Heterophyidae so the genus is hereby ascribed to that family. In sagittal sections of Cryptogonimus, "the double ventral sucker" of the original description, quoted by all subsequent writers, proves to be a ventro-genital complex within a depressed area, consisting of a submerged acetabulum and a gonotyl, with the genital pore between them. This genus also belongs within the family Heterophyidae. The genus Microphallus, which has been ascribed to the Heterophyidae by several authors, has several characters which seem to exclude it from this family. A previously unknown genus of trematode from fishes, which is being described in a paper now in press, has marked similarity to the organization of Allacanthochasmus and represents a fourth genus of North American fresh-water fish parasites which are shown to belong within the family Heterophyidae.

*A Trypanoplasm on the Gills of Carp from the Schuylkill River.* D. H. Wenrich, University of Pennsylvania.

During the latter part of September and early part of October, 1931, a great many fish, mostly carp (*Cyprinus carpio*), were observed to be in distress or dead at certain places along the Schuylkill River in Philadelphia. Some of the carp were examined for parasites, and a trypanoplasm was found on the gills. These flagellates were apparently limited to the gills and none were found in the blood. A few specimens of Trichodina were also noted on the gills. On account of the small number of these ectozoic flagellates it is thought that they were not the cause of the distress and death of the fish. The structure of this trypanoplasm is somewhat different from that attributed to *T. carassii* described by Swezy from the skin of goldfish, and different from *T. cyprinus* from the blood of European carp. It is expected that further study will make possible the determination of the taxonomic status of this flagellate.

*Production of Sterile Maggots for Surgical Use.* G. F. White, Bureau of Entomology, United States Department of Agriculture.

Strains of *Lucilia sericata* and *Phormia regina* have been maintained throughout the year relatively free from dangerous micro-organisms. From these an adequate supply of eggs has been obtained. In rearing larvae a pan containing ground meat is placed within a larger one containing fine wood shavings and provided with a lid having a large window covered with cotton and cheesecloth, and autoclaved. Sterilized eggs are placed on the meat. Migrating larvae are trapped in the shavings and pupate. These may be used immediately, stored in the icebox, or shipped. Flies from these emerge in sterile cages, are given food relatively free from disease-producing organisms, and kept in a cabinet with regulated temperature and humidity and supplied with dust-free air. Eggs from these flies are sterilized in the production of maggots for the surgeon. A satisfactory disinfecting solution for the eggs consists of mercuric chloride, 0.25 Gm.; sodium chloride, 6.5 Gm.; hydrochloric acid, 1.25 cc.; ethyl alcohol, 250 cc.; distilled water, 750 cc. Five per cent formalin gives good results also. After immersion for 15 minutes in either solution the eggs are strained through cheesecloth in a Gooch crucible, washed, and transferred with the cloth to a large vial containing glucose, peptonized agar, and meat. On the second day cultures are made of this medium upon which the larvae are feeding, and all vials are placed in the icebox. Larvae proven sterile in this way are ready for the surgeon. Aseptic technique comparable to that observed by the surgeon is practiced throughout.

*Lesions of the Pancreas of Turtles Caused by Parasites.* Elsie Wieczorowski, Northwestern University.

Two types of lesions, tumors and nodules, were found in the pancreas of turtles. Tumors were always located in the region of the main pancreatic duct. Nodules were scattered throughout the tissue. These lesions were found to be due to eggs and larval stages of nematodes, and eggs and immature trematodes. Nematode eggs reach the pancreas by the blood vessels. Larval nematodes, immature trematodes, and trematode eggs invade the pancreas by way of the pancreatic duct. The lesions are evidently a protective mechanism set up by the host tissues. The pancreas evidently is not a specific host organ in the life cycle of the invading parasites.

*The Anthelmintic Value of Some Halogenated Hydrocarbons Containing Iodine and Bromine.* Willard H. Wright and Jacob M. Schaffer, Bureau of Animal Industry, United States Department of Agriculture.

Critical tests with n-propyl iodide, n-butyl iodide and n-amyl iodide indicate that none of these compounds exert a high degree of anthelmintic efficacy for hookworms in the dog. On the other hand, n-propyl iodide and n-amyl iodide proved to be very effective ascaricides, since these compounds, in doses as low as 0.1 cc. per kilogram of body weight, commonly removed all the ascarids present in the test animals. In preliminary tests, n-butyl bromide showed a high degree of efficacy against both ascarids and hookworms in the dog. The results of tests with this small number of compounds in these two series considered together with the results obtained in previous tests with mono-chlorinated hydrocarbons lead to the tentative conclusion that the water solubility of mono-halogenated hydrocarbons is of greater importance in relation to anthelmintic efficacy than is the kind of halogen atom present.